

2006 Restoration Thinning Plan

A Document Describing 2006 Restoration Thinning Design, Implementation, and Lessons Learned

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1.0 Background

One overarching goal of the Cedar River Watershed Habitat Conservation Plan (HCP) is to accelerate the development of late-successional forest characteristics, ultimately providing wildlife habitat for species of concern and maintaining biological diversity. In a landscape that has been managed for resource extraction for more than one hundred years, time is necessary to achieve this restoration goal. The HCP provides for two upland forest thinning programs: restoration thinning in young stands (generally less than 30 years) and ecological thinning in older stands (generally less than 60 years). This document describes the design and construction activities for restoration thinning that occurred in 2006.

1.1 Organization

Prior to 2006, potential restoration thinning units were identified from a variety of different and varying sources. These sources combined forest cruises from the early 1970s (Walker survey) of which some of the areas had been harvested post 1970's, harvest history maps which did not include USFS harvest history, and personal knowledge of the watershed. While this pre-2006 approach to identifying potential restoration thinning units was functional, there were inaccuracies in the source material, varying stand attributes identified as restoration thinning candidates (for example: tree heights between restoration thinning stand candidates varied from stand averages of 10 feet to >50 feet), and a level of uncertainty regarding what characteristics the target restoration thinning stands should possess and how many acres of these types of stands existed across the CRW landscape. There was also no clear prioritization scheme regarding the order in which potential restoration thinning units should be treated.

The writers of the HCP intended the restoration thinning program to address those areas within the CRW that had been harvested in the recent past (1970-present; approximately 30 year old and younger trees). The 50 year HCP, designed as a cost commitment HCP, committed fifteen years of funding to the restoration thinning program. That fifteen year horizon intended all the restoration thinning candidates to have been treated by the year 2015. Restoration thinning candidates and treated units have morph-sized beyond stands 30 years and younger (due to site class variations and new discoveries on the CRW landscape). What is an obvious dilemma is that it is unclear exactly what a restoration candidate is and it is equally unclear how many acres of these ever changing candidates there are in the CRW.

1.2 Candidate Pool

Defining what a restoration thinning candidate is and determining how many acres of these candidates exist in the CRW is paramount to management of the restoration thinning program. The CRW does not have a forest inventory, which would be a likely source for this type of information. Other existing sources, Walker survey, harvest history maps and atlas information, stand typing information with no assigned attributes, were investigated for the purpose of identifying a restoration thinning candidate pool. All of these sources were problematic for unique reasons. An investigation into using a relatively new data set: LiDAR, was conducted and the results were promising

The LiDAR data set is able to provide reliable ground elevation (topography) information as well as information about average canopy height. Focusing on LiDAR derived canopy heights seemed like a reliable route to deciphering the restoration thinning candidate pool. The candidate pool was categorized into tree height categories, acre summaries were done to the categories, and the results were compared to the projected HCP restoration thinning budget through and ending in the year 2015. From this category-acre-budget analysis it was determined that an appropriate way to define the restoration thinning candidate pool was to consider stands of trees whose average canopy height was less than or equal to thirty feet. The LiDAR data set identified that there was just over 12,000 acres in this candidate pool. This 12,000 acre sized candidate pool seems robustly realistic to consider treating in the next ten years with the dollars available. Applying restoration thinning treatments to stands of trees that are thirty feet tall and shorter is realistic as well.

1.3 Prioritizing Restoration Thinning Units

Ecologists who work in the CRW have struggled with how to defensibly prioritize restoration activities. In other words, during the implementation of the fifty year HCP where should restoration activities occur first and why. When considering restoration, water features and older forests seem particularly valuable from a habitat perspective. Based on presence or nearness to water (streams, wetlands) a GIS derived landscape

map was created which identifies areas to be focused on for future restoration activities. Older forests and/or water are correlated with habitat use, species diversity, species abundance and overall richness. The breadth and depth of the habitat is broader and deeper in the areas with water and older forests. To prioritize restoration efforts near these areas ideally will provide a positive contribution and/or improve the habitat greater than if the previously disturbed landscape was allowed to evolve on its own.

The GIS landscape map was used as an over-layer to the LiDAR derived restoration thinning candidate pool map. This overlay comparison provided a means with which to rank the restoration thinning candidate pool based on nearness to habitat of significant value (water, older forest). Simply, the restoration thinning unit ranked one has the greatest potential to provide important habitat improvement with appropriate restoration activities.

1.4 Road Decommissioning & Prioritization

The road decommissioning program in the CRW focus' on removing segments of roads that are determined to be not necessary for current or future operations as well as removing roads that are problematic relative to sediment contributions (to water), drainage problems, or instability. Coordinating restoration thinning activities with the road decommissioning program is valuable and efficient. Prioritizing restoration thinning units in an area identified for road decommissioning makes better sense than decommissioning the road and sometime in the future requiring the contractor to walk the decommissioned road to access the restoration thinning unit. All the units planned for 2006 were selected based on road decommissioning work planned for 2007.

2.0 Objectives for 2006 Restoration Thinning Program

As in years past, the ecological objectives for restoration thinning include: accelerating the stand development pathway through the stem exclusion stage, maintaining or increasing the growth rate of trees, facilitating future recruitment of large diameter snags and coarse woody debris, increasing plant species diversity, protecting special habitats, and protecting water quality. The prescriptions for 2006 silviculture treatments varied continue to focus on these ecological objectives and include these additional objectives:

- Designing and implementing restoration thinning treatments to provide for varying forest stand structures and development pathways;
- Minimizing continuous slash loading adjacent to older RT units; and
- Minimizing slash loading adjacent to older forest edges
- Treating slash in different ways to address City and stakeholder concerns

3.0 Design

3.1 Restoration Thinning Installments

2006 Restoration thinning was designed as one installment consisting of ten separate units composed of 316 acres. Seven of the units are located in the Rack Creek basin, two of the units are located in the Lindsay Creek basin and one of the units is located in the Lost Creek basin. Nine of these units were selected to coordinate with road decommissioning projects scheduled for 2007. The ten units vary in size from a small of fifteen acres to a large of fifty-five acres

3.2 Unit Characteristics

The 2006 units represent historic logging units that were clear cut harvested under US Forest Service management. Based on pre-treatment data analysis, particularly with regard to species present, it is assumed that these units all regenerated naturally with little to no supplemental planting. The current tree community is dominated by silver fir (*Abies amabilis*) and western hemlock (*Tsuga heterophylla*), two species that were not historically planted supporting this natural regeneration assumption. (note: in the more recent past, western hemlock is being grown by nurseries and included in planting prescriptions). Table 1 provides pretreatment summary information regarding trees per acre and species mix.

The prescriptions for all ten units are designed to preserve the minority species, ideally preserving the less abundant species in the landscape and promoting their growth; however, all units will continue to be

dominated by silver fir and western hemlock because of these two tree species domination in the present tree community population. The prescriptions do attempt to move the units away from tightly spaced homogenous configurations into spacings and configurations that promote tree growth and spacing variability and integrate the ecological objectives stated above.

Table 1: Pretreatment data summary of trees per acre (tpa) and species composition

Unit #	Total tpa							Sample Size (n=)
		ABAM	TSHE	ABPR	PSME	THPL	ALRU	
2	2580	2160	340	60	20	0	0	5
23	3417	1583	1667	83	83	0	0	3
31	7125	4625	2250	0	0	0	0	4
49.1	1150	3083	7750	83	83	83	0	3
49.2	3750	2916	583	0	250	0	0	3
52	3500	500	2667	0	250	83	0	3
62	5750	83	5000	167	417	83	0	3
65	1583	167	14167	167	833	333	0	3
74	1720	900	580	100	60	80	0	5
79	1675	125	1000	0	325	25	200	4

3.3 Restoration Thinning Slash Treatments

Observations of restoration thinning units thinned within the past six years (2000-2005) provide an indication that in the upper watershed at higher elevations (2000'+) of a slower rate of slash decomposition. It is assumed that this restoration thinning related slash may pose a fire risk as well as potentially limit wildlife access and understory development for several years post treatment.

Overall tree size (diameter, height) was variable within the units targeted for restoration thinning prior to 2006; with some of the units tree sizes averaging 7"+ diameter and 40'+ height. The size of the tree (diameter and height) and amount of slash (trees per acre) is assumed to be correlated with rate of slash decomposition. The 2006 restoration thinning program, as mentioned earlier in this report, initiated a category-acre-budget analysis determining that an appropriate way to define the restoration thinning candidate pool was to consider stands of trees whose average canopy height was less than or equal to thirty feet. In other words, the units identified for thinning in 2006 (and beyond) did not exceed 30' in height, with some unit's average tree heights being considerable shorter. Table 2: Pretreatment unit data comparing height, dbh and age provides 2006 tree size by unit information. While it is assumed that thinning units of smaller sized trees will result in a faster rate of slash decomposition, all 2006 restoration thinning units did involve slash treatment as part of their treatment prescription.

Table 2: Pretreatment unit data comparing height, dbh and age

Unit #	Average height (in feet)	Average dbh (in inches)	Average age (dbh)	Sample size (n=)
2	11	1.6	29	5
23	10	1.5	12	3
31	8	1.1	Not available	4
49.1	7	1.0	Not available	3
49.2	7	1.3	29	3
52	7	1.4	8	3
62	7	1.0	10	3
65	7	1.0	13	3

74	8	2.5	17	5
79	10	3.1	27	4

3.3.1 2006 Slash Treatment

To address the increasing slash load and potential fire risk, all 2006 prescriptions included slash treatments, primarily lopping. Additionally, five of the 2006 thinning units required the contractor to pull back restoration thinning related slash where these four units shared a boundary with older forests. Treating thinning slash significantly increases the treatment costs. For example, lopping thinning slash in all cases in 2006 cost the City more per acre to accomplish than the thinning costs alone and slash pull-back from the older forest edges alone is considerable more expensive than lopping. Lopping and slash pull back are more labor intensive, take more time to accomplish than the actual thinning which results in higher costs. Actual 2006 costs are provided in Table 3: Summary of thinning and slash treatment costs for 2006 restoration thinning units. At this time, it is unclear which treatment option is the most cost-effective for reducing fire risk, enhancing wildlife use and facilitating understory development; it is clear that treating restoration thinning slash is a challenge.

Table3: Summary of thinning and slash treatment costs for 2006 restoration thinning units

Unit #	Per Acre Costs		
	Thinning	lopping	piling
2.1	\$92.00	\$124.00	\$850.00
2.2	\$74.00	\$88.00	\$850.00
23	\$160.00	\$230.00	Not available
31	\$169.00	\$230.00	Not available
49.1	\$170.00	\$200.00	Not required
49.2	\$160.00	\$225.00	Not available
52	\$167.00	\$210.00	Not required
62	\$204.00	\$224.00	Not required
65	\$174.00	\$194.00	Not required
74	\$147.00	\$152.00	Not required
79	\$141.00	\$164.00	Not required

Note: lopping is contractually defined as ““Lop entire unit leaving thinning slash no greater than 18” from the forest floor.”

4.0 Site Descriptions

Table 4 summarizes site and stand conditions for 2006 restoration thinning units. The table includes the following information for each unit:

- the unit name
- the basin in which it is located
- unit acres
- unit elevation
- unit aspect

Table 4: 2006 Unit summary, elevation, aspect

Unit Name	Basin	Acres	Elevation (' asl)	Aspect
2.1	Lost Creek	29	3,600	N
2.2	Lost Creek	15	3,600	N
23	Shotgun	18	3,600	E
31	Rack	20	3,600	W
49.1	Rack	15	3,200	E
49.2	Shotgun	22	3,600	N
52	Rack	42	3,000	W.

62	Echo	23	2,800	N
65	Rack	30	2,800	NW
74	Lindsay	55	2,600	W
79	Lindsay	46	2,600	W

5.0 Prescriptions and Rationale

SPU staff collected pre-treatment data for 2006 restoration thinning (and beyond). This data provided unit level details necessary for customizing unit prescriptions. Stump data were also collected as part of the suite of pre-treatment data. Using the stump data, the original forest (harvested forest) trees per acre was determined, and tree species present was noted. The sample was small, the variability within the sample was high; therefore in the case of the stump data, the information gathered was used to generally inform about the site, rather than provide target populations to manipulate present populations towards. Old growth permanent sample plot data in close proximity to the thinning units were also used to craft the prescriptions. 2006 Unit maps (Ortho photo) at 1:12000 scale are included in Appendix A. Prescriptions, as they appeared in the 2006 contract, are located in Appendix C.

5.1 Prescriptions That Applied to All 2006 Units

Prescriptions relating to skips (no thin), gaps (all trees cut), lopping slash and treatment of stream and wetland edges are the same for all ten 2006 restoration thinning units. Descriptions of these prescriptions and rationale is provided below.

Appendix A contains a complete set of maps with ortho photos of all of the 2006 restoration thinning units.

5.1.1 Skips and Gaps

Fifty foot diameter skips (no thin) and fifty foot diameter gaps (all trees cut) were incorporated into the prescription all the 2006 restoration thinning units. The number of skips and gaps per unit varied on production rate of the individual thinners. Each thinner was required to install one skip and one gap per production day. Production per individual thinner varies from a low of 1.5 acres per day to a high of 2.5 acres per day based on tree density, topography and skill level.

The objectives of incorporating skips and gaps included respecting natural clumpy stand development, promoting stand canopy heterogeneity, providing additional opportunities for under-story re-initiation, and preserving unique (little understood) micro-site under-story areas (skips). The prescriptions promoted flexible locations for skips and gaps, to be determined by the individual thinner or their foreman. This flexibility allowed the thinners to take advantage of natural gaps and also take advantage of areas that were particularly dense with regeneration. Giving the control for the location of skips and gaps to the thinners resulted in an application that respected natural stand development and of course in some cases minimized the work of the thinner.

While the prescription wording for skips and gaps, numbers, locations, size, etc was identical for all ten units covered in the contract; due to the variable production rate per thinner and the flexible location stipulation within the contract there was nothing homogenous about how the skips and gaps appeared on the landscape.

5.1.2 Lopping Restoration Thinning Slash

A slash lopping treatment was required in all the 2006 restoration thinning units. This slash lopping is intended to influence the decomposition rate of the thinning slash. Lopping is defined as cutting up the thinning slash so that it lies within approximately 18 inches of the forest floor. Lopping thinning slash will provide additional exposed surfaces of the slash and put the slash closer to the forest floor, ideally facilitating microbial activities and ultimately accelerating decomposition. It is assumed that lopping will speed the decomposition rate, so the duration of slash impacts will be lessened.

5.1.3 Stream and Wetland Treatments

All restoration thinning is performed to protect and not obstruct streams and wet areas that occur in the unit. The prescriptions required the following:

“For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual of perennial stream or wetland, or pond, or the upper break of an inner gorge.”

Additionally:

“Thin the first 20’ (either side = 40’ total) adjacent to the stream buffers to a 10x10 foot spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit).”

The spacing for this 40 foot area adjacent to the no cut stream buffer varied in one of the Lindsay Creek Units (Unit 74). In all units where the adjacent area was not associated with an inner gorge, this thinned spacing was required to be 10x10. In Unit 74 the spacing was required to be 8x8, due to the perceived greater erosive tendency of the soil type present in the Unit.

5.2 Unit Descriptions and Treatments

5.2.1 Unit 2.1 and 2.2

Landscape considerations:

- Chester Morse basin total: 7,747 acres
- Lost Creek headwaters
- Unit 2.1 is twenty-nine acres and Unit 2.2 is fifteen acres
- The Lost Creek sub-basin ranges in elevation from high of 4,000 feet at the divide between Lost Creek and North Fork Taylor Creek to a low of 1,600 feet where Lost Creek empties into the Masonry Pool.
- Current and future projections for older forests (old growth in this case defined as 190 years plus) in this Chester Morse basin are 1,277 acres for the years spanning 1997-2050.
- Mature forest (80-119 years old) is projected to change from 0 to 4,558 acres for the years spanning 1997-2050.
- Units 2.1 and 2.2 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050). Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Table 5: Forest Seral Stages in acres

Chester Morse Sub-basin		Projected		
Age range definition	Seral Stage	1997	2020	2050
0-9	Early seral-grass/forb stage	340	0	0
10-29	Early seral-open canopy	2,144	207	0
30-79	Mid seral closed canopy	5,591	3,915	1,595
80-119	Mature forest	0	3,892	4,558
120-189	Late-successional forest	0	0	1,862
190+	Old growth forest	1,277	1,277	1,277

Note: the information provided above is taken from “Resource Maps for the Final Cedar River Watershed Habitat Conservation Plan, City of Seattle April 2000”

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 2.1 and 2.2 included: current trees per acre data (2,580 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Eight of the units identified for 2006 thinning (units 2.1 and 2.2 included) occurred within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek), and considerations in developing these eight prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time. Seven of these 2006 units are located approximately one mile from one another while Units 2.1 and 2.2 are located slightly farther away. Units 2.1 and 2.2 are located one ridge over and to the west of the other 2006 six Units occurring in the Chester Morse sub-basin.

The dominant species in units 2.1 and 2.2 is silver fir (2,160 trees per acre). Western hemlock (340 trees per acre), noble fir (60 trees per acre) and Douglas fir (20 trees per acre) also occur (see Table 1). The pre-treatment characteristics of these two units is clumpy forest development, typical of natural regeneration silver fir stands. In other words, there are some areas within the unit boundary that are occupied by one hundred trees per acre and some areas that are occupied by 4,400 trees per acre, as observed with 1/100th acre plot sampling technique (n=5). Mountain beavers are active in this unit and are assumed to contribute some to the clumpy nature of forest development. Incorporating 50 foot diameter skips (no thinning required) and 50 foot diameter gaps (all trees will be cut) in the prescription for units 2.1 and 2.2 is intended to preserve some of this natural clumpy unit development into the future. The prescription is also intended to favor the less abundant species as leave trees; however, because these species are so few in numbers, the unit will remain dominated by silver fir.

A determination was made to create two units from the original 48 acre LiDAR derived unit 2. This division into two units is based on tree density and topography variations across the original 48 acres. Unit 2.1 is 29 acres and appeared to be occupied with a higher number of trees per acre and is located to the east, Unit 2.2 is 15 acres and is occupied with a lower number of trees per acre and is located to the west.

Unit 2.1 was given a spacing prescription of 17 x 17 foot spacing between trees, leaving the residual stand with 151 trees per acre to grow. Unit 2.2 was given a spacing prescription of 12 x 12 foot spacing between trees, leaving the residual stand with 302 trees per acre to grow. A species specific aspect of the prescription required the thinners to cut silver fir and western hemlock first, essentially favoring where present the minority species of noble fir and Douglas fir.

These two spacing prescriptions will reduce the tree per acre density in these units from 2,580 trees down to 151 (Unit 2.1) and 302 (Unit 2.2) trees per acre. Reducing the trees per acre is intended to shorten the amount of time that the trees are in the stem exclusion phase of development. Under natural conditions the stem exclusion stage for silver fir can last for 200 years (Silvics of North American Tree Species).

Slash Treatments:

In addition to lopping, slash pull-back was required within fifty feet of any older forest edge in both Unit 2.1 and Unit 2.2. Slash pull back is essentially relocating the restoration thinning related slash to an adjacent area basically creating, in this case, a fifty foot slash free zone. A perceived benefit of slash pull-back is to minimize any fuel load, thus minimizing potential fire threat and/or damage to the older forest if a fire should occur in this area. Another perceived benefit is to provide a fifty foot corridor for wildlife travel, hunting, and or foraging that is not obstructed by thinning related slash.

5.2.2 Unit 23

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Shotgun Creek headwaters
- Unit 23 is eighteen acres
- The Shotgun Creek sub-basin ranges in elevation from high of 4,000 feet at the divide between Shotgun Creek and Middle Fork Taylor Creek to a low of 1,600 feet where Shotgun Creek empties into Chester Morse Lake.
- Unit 23 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 23 included: current trees per acre data (3,417 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 23 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 23 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 23 is western hemlock (1,667 trees per acre) with silver fir (1,583 trees per acre) being nearly as dominant. Noble fir (83 trees per acre) and Douglas fir (83 trees per acre) also occur (see Table 1). The pre-treatment characteristics of this unit is clumpy development, typical of natural regeneration silver fir stands and similar to the other eight units located in this general area and thinned in 2006. The pretreatment data provided a range of tree densities between a low of 2,000 trees per acre to a high of 6,000 trees per acre as observed with 1/250th acre plot sampling technique (n=3). The prescription for unit 23 is intended to favor the less abundant species as leave trees; however, because these species are so few in numbers, the unit will remain dominated by western hemlock and silver fir.

Approximately 15% of the cleared area associated with Unit 23 as defined by LiDAR (but excluded from the contracted acres) is currently occupied by non-coniferous species, primarily vine maple and huckleberry. Currently and over time, this hardwood dominated area is and will continue to provide species, canopy and habitat diversity.

Unit 23 was given a spacing prescription of 13 x13 foot spacing between trees, leaving the residual stand with 258 trees per acre to grow. A species specific aspect of the prescription required the thinners to cut silver fir and western hemlock first, essentially favoring where present the minority species of noble fir and Douglas fir. This spacing prescription will reduce the tree per acre density in this unit from 3,417 trees down to 258 trees per acre.

Slash Treatments:

In addition to lopping, slash pull-back was required within fifty feet of any older forest edge in Unit 23. Slash pull back is essentially relocating the restoration thinning related slash to an adjacent area basically creating, in this case, a fifty foot slash free zone. A perceived benefit of slash pull-back is to minimize any fuel load, thus minimizing potential fire threat and/or damage to the older forest if a fire should occur in this area. Another perceived benefit is to provide a fifty foot corridor for wildlife travel, hunting, and or foraging that is not obstructed by thinning related slash.

5.2.3 Unit 31

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Tributary to Rack Creek
- Unit 31 is twenty acres
- This Rack Creek tributary sub-basin ranges in elevation from high of 4,000 feet at the divide between Rack Creek and Middle Fork Taylor Creek to a low of 1,600 feet where Rack Creek empties into Chester Morse Lake.
- Unit 31 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 31 included: current trees per acre data (7,125 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 31 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 31 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 31 is silver fir (4,625 trees per acre). Western hemlock is also present (2,250 trees per acre). No other tree species were measured during pretreatment sampling (see Table 1). The pre-treatment characteristics of this unit is clumpy development, typical of natural regeneration silver fir stands and similar to the other eight units located in this general area and thinned in 2006. The pretreatment data provided a range of tree densities between a low of 1,500 trees per acre to a high of 16,000 trees per acre

as observed with 1/500th acre plot sampling technique (n=4). Unit 31 will remain dominated by western hemlock and silver fir.

Approximately 30% of the area associated with Unit 31 as defined by LiDAR (but excluded from the contracted acres) is comprised of open areas mixed with dense patches of conifer. This area was eliminated from the treated acres; however this unthinned area contributes to habitat diversity now and into the future. This mixed cover area appears to have an active population of mountain beaver based on observed foraging activity and excavation activity.

Unit 31 was given a spacing prescription of 11 x11 foot spacing between trees, leaving the residual stand with 360 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 7,125 trees down to 360 trees per acre.

Slash Treatments:

In addition to lopping, slash pull-back was required within fifty feet of any older forest edge in Unit 31. Slash pull back is essentially relocating the restoration thinning related slash to an adjacent area basically creating, in this case, a fifty foot slash free zone. A perceived benefit of slash pull-back is to minimize any fuel load, thus minimizing potential fire threat and/or damage to the older forest if a fire should occur in this area. Another perceived benefit is to provide a fifty foot corridor for wildlife travel, hunting, and or foraging that is not obstructed by thinning related slash.

5.2.4 Unit 49.1

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Tributary to Echo Creek
- Unit 49.1 is fifteen acres
- Echo Creek flows directly into Chester Morse Lake. The elevations in the Echo Creek drainage range from a high of 3,600 feet at the divide between Echo Creek and Rack Creek and Shotgun Creek tributaries to a low of 1,600 feet where Echo Creek empties into Chester Morse Lake.
- Unit 49.1 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 49.1 included: current trees per acre data (11,500 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 49.1 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 49.1 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 49.1 is western hemlock fir (7,750 trees per acre). Silver fir (3,083 trees per acre), noble fir (83 trees per acre), Douglas fir (83 trees per acre) and western red cedar (83 trees per acre) are also present. The pre-treatment characteristics of this unit is clumpy development, typical of natural regeneration silver fir stands and similar to the other eight units located in this general area and thinned in 2006. The pretreatment data provided a range of tree densities between a low of 3,750 trees per acre to a high of 16,000 trees per acre as observed with 1/250th acre plot sampling technique (n=3). Unit 49.1 will remain dominated by western hemlock and silver fir.

Unit 49.1 was given a spacing prescription of 17 x17 foot spacing between trees, leaving the residual stand with 151 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 11,500 trees down to 151 trees per acre.

Slash Treatments:

Lopping was the only slash treatment applied in Unit 49.1. The majority of the Unit is surrounded by forest road, which provides a potential fire break between the thinning unit and the surrounding older forests.

5.2.5 Unit 49.2

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Tributary to Shotgun Creek
- Unit 49.2 is twenty-two acres
- Shotgun Creek flows directly into Chester Morse Lake. The elevations in the Shotgun Creek drainage range from a high of 4,000 feet at the divide between Shotgun Creek, Rack Creek and Middle Fork Taylor Creek to a low of 1,600 feet where Shotgun Creek empties into Chester Morse Lake.
- Unit 49.2 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 49.2 included: current trees per acre data (3,750 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 49.2 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 49.2 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

Unit 49.2 has several rock outcroppings within the unit and the appearance of rocky gravelly soil with a very shallow to non existent soil organic layer present. The pre-treatment forest composition is patchy with areas occupied by no coniferous trees. Vine maple and huckleberry occur throughout the Unit. Red alder occupies the majority of the decommissioned road-bed at the bottom (east) Unit 49.2

The dominant species in unit 49.2 is silver fir (2,916 trees per acre). Western hemlock (583 trees per acre) and Douglas fir (250 trees per acre) are also present. The pre-treatment characteristics of this unit is clumpy development, typical of natural regeneration silver fir stands and similar to the other eight units located in this general area and thinned in 2006. The pretreatment data provided a range of tree densities between a low of 750 trees per acre to a high of 9,250 trees per acre as observed with 1/250th acre plot sampling technique (n=3). Unit 49.2 will remain dominated by silver fir.

Unit 49.2 was given a spacing prescription of 11 x 11 foot spacing between trees, leaving the residual stand with 360 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 3,750 trees down to 360 trees per acre.

Slash Treatments:

A Fifty foot slash pull back (slash free zone) was prescribed along the older forest edge in Unit 49.2.

5.2.6 Unit 52

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Tributary to Rack Creek
- Unit 52 is forty-two acres
- Rack Creek flows directly into Chester Morse Lake. The elevations in the Rack Creek drainage range from a high of 3,600 feet at the divide between Rack Creek and the North Fork Taylor Creek basins to a low of 1,600 feet where Rack Creek empties into Chester Morse Lake.
- Unit 52 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 52 included: current trees per acre data (3,500 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 52 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 52 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

Unit 52 has a large rock outcrop within the upper portion of the unit and the appearance of variable site characteristics within the Unit boundaries. The coniferous trees vary in appearance from yellowish needles and small in height and diameter growth to greenish needles and a more typical (for the age) height and diameter growth.

Occupying areas disturbed by the road building and harvesting operations is red alder. Approximately 10% of the LiDAR derived unit is occupied by primarily vine maple and huckleberry and devoid of conifer. This area is excluded from the treatment acres, but should provide short term and long term habitat benefits as it will continue to be populated by deciduous shrub type species.

The dominant species in unit 52 is western hemlock (2,667 trees per acre). Silver fir (500 trees per acre), Douglas fir (250 trees per acre) and western red cedar (83 trees per acre) are also present. The pretreatment data provided a range of tree densities between a low of 750 trees per acre to a high of 7,000 trees per acre as observed with 1/250th acre plot sampling technique (n=3). Unit 52 should realize a more equitable species mix with western hemlock, silver fir and Douglas fir as primary species.

Unit 52 was given a spacing prescription of 12 x 12 foot spacing between trees, leaving the residual stand with 302 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 3,500 trees down to 302 trees per acre.

5.2.7 Unit 62

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Echo Creek Basin
- Unit 62 is twenty-three acres
- Echo Creek flows directly into Chester Morse Lake. The elevations in the Echo Creek drainage range from a high of 3,600 feet at the divide between Echo Creek and Rack Creek and Shotgun Creek tributaries to a low of 1,600 feet where Echo Creek empties into Chester Morse Lake.
- Unit 62 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 62 included: current trees per acre data (5,750 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 62 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 62 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 62 is western hemlock (5,000 trees per acre). Douglas fir (417 trees per acre), noble fir (167 trees per acre), silver fir (83 trees per acre) and western red cedar (83 trees per acre) are also present. The pretreatment data provided a range of tree densities between a low of 1,750 trees per acre to a high of 7,750 trees per acre as observed with 1/250th acre plot sampling technique (n=3).

Unit 62 was given a spacing prescription of 13 x 13 foot spacing between trees, leaving the residual stand with 258 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 5,750 trees down to 258 trees per acre.

5.2.8 Unit 65

Landscape Considerations

- Chester Morse basin total: 7,747 acres
- Rack Creek Basin
- Unit 65 is thirty acres
- Rack Creek flows directly into Chester Morse Lake. The elevations in the Rack Creek drainage range from a high of 3,600 feet at the divide between Rack Creek and the North Fork Taylor Creek basins to a low of 1,600 feet where Rack Creek empties into Chester Morse Lake.
- Unit 65 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 5: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 65 included: current trees per acre data (15,833 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 65 occurs within the Chester Morse sub-basin (Lost Creek, Rack Creek and Shotgun Creek). Unit 65 is located less than one mile from six other restoration thinning units treated in 2006. Considerations in developing these seven prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 65 is western hemlock (14,167 trees per acre). Douglas fir (833 trees per acre), noble fir (167 trees per acre), silver fir (167 trees per acre) and western red cedar (333 trees per acre) are also present. The pretreatment data provided a range of tree densities between a low of 4,000 trees per acre to a high of 29,500 trees per acre as observed with 1/500th acre plot sampling technique (n=3).

Unit 65 was given a spacing prescription of 14 x 14 foot spacing between trees, leaving the residual stand with 222 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 14,167 trees down to 222 trees per acre. The post-treatment unit should have a diverse conifer species mix, as there was a diverse mix based on pre-treatment data.

5.2.9 Unit 74

Landscape Considerations

- Rex River sub- basin total: 8,089 acres
- Lindsay Creek Basin
- Unit 74 is fifty-five acres
- The elevations in the Lindsay Creek drainage range from a high of 4,360 feet (top of Mount Lindsay) to a low of 1,760 feet where Lindsay Creek joins the Rex River. The topography of the upper reaches of the Lindsay Creek basin define the divide between Lindsay Creek and the North Fork of the Green River. This divide also defines the Cedar River Watershed boundary (city of Seattle ownership).
- Unit 74 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 6: Forest Seral Stages in acres provides additional information on this subject in this basin.

Table 6: Forest Seral Stages in acres

Rex River Sub-basin		Projected		
Age range definition	Seral Stage	1997	2020	2050
0-9	Early seral-grass/forb stage	54	0	0
10-29	Early seral-open canopy	4,434	0	0
30-79	Mid seral closed canopy	7,962	8,673	3,463
80-119	Mature forest	13	3,754	8,599

120-189	Late-successional forest	0	0	366
190+	Old growth forest	1,737	1,737	1,737

Note: the information provided above is taken from "Resource Maps for the Final Cedar River Watershed Habitat Conservation Plan, City of Seattle April 2000"

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 74 included: current trees per acre data (1,720 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 74 occurs within the Lindsay Creek sub-basin, which is a tributary to the Rex River. Unit 74 is located less than ½ mile from one other restoration thinning unit treated in 2006. Considerations in developing these two prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 74 is silver fir (900 trees per acre). Western hemlock fir (580 trees per acre), noble fir (100 trees per acre), Douglas fir (60 trees per acre) and western red cedar (80 trees per acre) are also present. The pretreatment data provided a range of tree densities between a low of 800 trees per acre to a high of 3,400 trees per acre as observed with 1/100th acre plot sampling technique (n=5).

Unit 74 was given a spacing prescription of 13 x 13 foot spacing between trees, leaving the residual stand with 258 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 1,720 trees down to 258 trees per acre. The post-treatment unit should have a diverse conifer species mix, as there was a diverse mix based on pre-treatment data.

Unit 74 and Unit 79 (both occurring in the Lindsay Creek sub-basin and within ½ mile of one another) appear more productive than the other 2006 restoration thinning units located in the Chester Morse sub-basin. This productivity is based on tree growth. The two unit, 74 and 79, characteristics include more available moisture (wetter site), deeper soil substrate, and assumed better soil nutrient transfer capabilities. The Lindsay Creek sub-basin as a whole is much different than the Chester Morse sub-basin based on number of streams. The streams in Lindsay Creek are more frequent in number and perennial in nature, when compared to the Chester Morse sub-basin.

5.2.10 Unit 79

Landscape Considerations

- Rex River sub- basin total: 8,089 acres
- Lindsay Creek Basin
- Unit 79 is forty-six acres
- The elevations in the Lindsay Creek drainage range from a high of 4,360 feet (top of Mount Lindsay) to a low of 1,760 feet where Lindsay Creek joins the Rex River. The topography of the upper reaches of the Lindsay Creek basin define the divide between Lindsay Creek and the North Fork of the Green River. This divide also defines the Cedar River Watershed boundary (city of Seattle ownership).
- Unit 79 will contribute to the Mid Seral Closed Canopy (defined as 30-79 years old) category during the next 50 years (HCP time commitment 2000-2050).
- Table 6: Forest Seral Stages in acres provides additional information on this subject in this basin.

Forest Stand Condition and prescription considerations: Considerations in crafting the thinning prescriptions for unit 79 included: current trees per acre data (1,675 total trees per acre), old growth permanent sample plot trees per acre data, and the objectives of maintaining/enhancing tree growth and promoting understory development. Unit 79 occurs within the Lindsay Creek sub-basin, which is a tributary to the Rex River. Unit 79 is located less than 1/2 mile from one other restoration thinning unit treated in 2006. Considerations in developing these two prescriptions included their potential landscape interrelatedness and contributions to the forested landscape over time.

The dominant species in unit 79 is western hemlock (1000 trees per acre). Douglas fir (325 trees per acre), silver fir (125 trees per acre), and western red cedar (25 trees per acre) are also present. Red alder is found

more frequently in Unit 79 (200 trees per acre) when compared with other restoration thinning units treated in 2006. The pretreatment data provided a range of tree densities between a low of 700 trees per acre to a high of 2,300 trees per acre as observed with 1/100th acre plot sampling technique (n=4).

Unit 79 was given a spacing prescription of 15 x 15 foot spacing between trees, leaving the residual stand with 194 trees per acre to grow. This spacing prescription will reduce the tree per acre density in this unit from 1,675 trees down to 194 trees per acre. The post-treatment unit should have a diverse conifer species mix including red alder, as there was a diverse mix based on pre-treatment data.

6.0 Implementation

6.1 Vendor Pool

Currently restoration thinning work is performed with contractors under a blanket vendor contract. The prescriptions and specific contract are developed annually and a request for bid is solicited from the qualified group of vendors. To become a qualified vendor, the contractor had to fill out a questionnaire and go through a contracting process developed by City Purchasing Services. The vendors' completed questionnaires were evaluated and scored by City staff. This process resulted in a vendor pool of three qualified contractors – Ramirez Reforestation, Wild West Reforestation, and Mt. St. Helens Reforestation.

6.2 Contract

With every restoration thinning bid package, a contract between the City and the successful contract bidder is required. This contract not only includes the specific units and prescriptions, but also detailed information including the following:

- General specifications, technical specifications, measurement and payment. This section includes information specific to the treatment units including access information, unit boundary information, definitions specific to on the ground activities, and descriptions of what is required in the contract.
- Inspection and Acceptance information. This section includes information about quality control and quality assurance relating to prescription implementation.
- Commencement, prosecution and completion of work. This section includes information about beginning work, and sequencing this multiple unit contract
- Contract Administration. This section includes information about the project manager's (City) roles and responsibilities, the Contractor's responsibilities; as well as definitions specific to contract language.
- Fire Prevention and Control. This section includes information specific to the state regulations about fire prevention requirements, and general information relative to conducting business within the Cedar River Watershed boundaries including sanitation requirements.

Every year the majority of the contract language remains unchanged. That said, every year there are variables and new clauses added to the contract. The major changes to the 2006 contract included requiring slash pull back along older forest edges in four of the restoration thinning units and requiring the contractor to use bio-based bar-oil in all their chain-saws.

A copy of the 2006 contract is included in Appendix B: City of Seattle Watershed Management Division Restoration Thinning Contract Specifications year 2006

6.3 Solicitation

The three contractors (vendor pool) eligible to bid on restoration thinning work were sent by US mail the 2006 contract for bid in August 2006. The contractors are allowed access to the watershed to inspect the units, unescorted. These contractors are given approximately a two week time frame from the date they receive the contract to the date when bids are due.

6.3.1 Award

The restoration thinning work is awarded to the contractor(s) based on bid amount, location of the units, and ability to get the work done before limiting seasonal changes (snow). In the case of the 2006 units, the work was awarded to two contractors: Ramirez Reforestation and Wild West Reforestation. This award was

based on low bid on a unit by unit basis. The successful bidders are notified by phone and by mail. The notification sent by mail includes in writing, the units the contractor is expected to complete.

6.4 First Steps

After the award of the contract a pre-work meeting is scheduled between the restoration thinning project manager and the contractor. Subjects covered at this pre-work meeting include the following:

- Specific contract information, including prescription clarification, successful completion and payment requirements, and other pertinent items requiring emphasis.
- Fire prevention requirements, including a review of the state regulations
- Cedar River Watershed sanitation requirements, with a particular emphasis on sani-cans.
- Access information. The Cedar River Watershed is currently requiring all users to subscribe to the Cedar River Access Permit System (CAPS). The CAPS system provides the management of the Cedar River Watershed up to date information regarding individuals accessing the watershed, and provides the contractor with key-cards and keys to allow them access.
- A schedule of units and their planned completion, contractor crew-power and start date is also discussed at the pre-work.

6.4.1 Cultural Resource Protection

A requirement for all contractors doing work in the Cedar River Watershed is to be informed about and to sign the form: Cultural Resource Protection for Contractors working in the Cedar River Municipal Watershed. In a basic sense this form and contractor commitment states that all artifacts are to be left where they are found, appropriately protected from damage that the contracted activity may cause, and the project manager and/or compliance officer should be notified of the finding and its location. Basically, if an object or site is at least 50 years old, it is protected by local, State and Federal law.

6.5 Compliance

The goal of compliance is achieving the intended on the ground results and rewarding the contractor for a job well done by paying them the full amount and maintaining a good relationship. Ideally, compliance should be a win – win situation.

6.5.1 Inspection

Compliance on site involves inspecting the restoration thinning work and determining if the prescription is being applied as intended. As the prescriptions increase in complexity, traditional inspection sampling methods do not always apply. For example, a traditional inspection sampling method involves measuring trees on a fixed plot (for inclusion, diameter and species mix) to determine if the spacing prescription is being met. This fixed plot sampling method was used during 2006 compliance.

Performing compliance on the skips and gaps portion of the prescription did not fit the fixed plot sampling method. The flexibility allowed the contractor regarding location and numbers (based on variable production rate) did not lend itself to traditional sampling methods. What was able to be measured was the size of the skips and gaps, which required a fifty foot radius; however this fifty foot radius was not a precise measurement, as some gaps were located in areas that were larger naturally occurring gaps. When possible it is interesting to get an across the landscape view of the units, from this perspective, the skips in particular stand are easy to identify in the 2006 restoration thinning units. More specifically, Units on the east side of Rack Creek (Units 52 and 65) can be observed from various points on the 810 and 811 roads.

The inspection of the units was performed by two compliance people. One compliance person was responsible for inspecting all the Units thinned by Wild West Reforestation, and the other compliance person was responsible for inspecting most of the Units thinned by Ramirez Reforestation. When a particular Unit was completed by the contractor and the compliance person was satisfied that the prescription had been adequately implemented the okay was given to the contractor to submit an invoice for payment. On receipt of the invoice, the project manager applied appropriate budget coding and forwarded the invoice to the Accounts Payable department. Payment for completed work typically happens thirty days from Accounts Payable's receipt of the invoice.

6.6 Summary of contracting costs

Restoration thinning work in 2006 was awarded to two contractors. Table 3 summarizes 2006 contract costs. This table provides information about the external costs of implementing the 2006 restoration thinning program.

6.7 General Accomplishments

2006 presented variations of prescriptions for the contractors and contract compliance staff to implement. In total 316 acres were treated. By comparison, in 2005 704 acres were treated in two phases. The reasons for the decrease in treated acres in 2006 are two fold: 1. An important shift in restoration thinning work focus which took a fair amount of time and resulted in a long term list of potential restoration thinning candidates. Long term in this case is defined as all restoration thinning areas to be considered for thinning through 2015, which is the planned for end of the restoration thinning program. Collecting pre-treatment data on select restoration thinning units for use in crafting restoration thinning prescriptions was an important part of this long term candidate focus. 2. Approximately 1/3 of the 2006 restoration thinning budget identified for contracted services (contractors) had been spent on various mechanized slash treatments. In other words, there was less budgeted dollars available for actual restoration thinning work.

6.8 Issues Encountered

- All Units thinned restoration thinned in 2006 required lopping. The contractor's approach to lopping is to go through the entire unit and apply the spacing prescription; when the spacing is complete the contractor then applies the lopping prescription. Compliance is done by physically traversing the unit measuring and recording plot level data and visual observations between plots. Ideally compliance results in the compliance person working closely behind the contractor. Compliance plots often reflected partial completion of the work; in other words, compliance plots could be measured on the spacing prescription before the lopping prescription had been completed. This does not mean that the lopping was not inspected. What it does mean is that from a compliance perspective, this two phased spacing - lopping approach can confound the data, particularly compliance data summary. It is important to perform compliance on the spacing phase of the contracted work to ensure that the spacing prescriptions are being met. Waiting until the spacing and lopping are totally complete may result in a spacing work that does not meet the prescription.
- Measured plot level data provides information to the compliance person and the contractor about whether or not the prescription is being met. When the contractor is making errors it is important for the compliance person to provide information about the errors to the contractor (typically to the on-site foreman) as well as guidance on how to correct the errors. Where possible, the contractor will re-treat an area if that is the best solution to applying the prescription. Informing the contractor of a needed change in the spacing prescription prior to lopping is ideal. With this sequence, the contractor is then able to better address the spacing prescription at the same time as lopping; essentially covering the same ground twice, rather than three times.
- The thinning prescriptions in 2006 varied from a relatively wide spacing of 17x17 (151 trees per acre) to a relatively tight spacing of 11x11 (360 trees per acre). It is an observed tendency of the thinning contractor to have more difficulty thinning wider (17 x 17) prescriptions. More specifically, the contractor's tendency is to under-thin, or leave too many trees. This is a correctable offense, and is typically addressed during the lopping phase of the treatment. Unit 49.1 was particularly problematic for the thinners to apply the correct spacing. This unit was particularly dense (see appendix A for ortho-photo representation), varied considerably in tree sizes, and the contractor had preceded their work on 49.1 with treating Unit 31, which was 11x11 spacing. Table 7: provides information about the 2006 units and their spacing prescriptions.

Table 7: Spacing and Trees per Acre Comparison

Unit #	Spacing Prescription	Trees per acre
2.1	17X17	151
2.2	12x12	302
23	13x13	258

31	11x11	360
49.1	17x17	151
49.2	11x11	360
52	12x12	302
62	13x13	258
65	14x14	222
74	13x13	258
79	15x15	194

- All 2006 restoration thinning units required the thinning contractors to install skips (cut no trees) and gaps (cut all trees) in the units. The number of skips and gaps installed in each unit was flexible. While this flexibility complemented the increased spatial and canopy heterogeneity, it posed some difficulties from a compliance perspective. More specifically, because there was no set number of skips and gaps applied in each unit, it was impossible to determine if the contractors had installed the “correct” number. While the contractors we used in 2006 were trust-worthy had intentions of doing quality work, it may have been better to prescribe the number of skips and gaps to be applied based on unit acres.
- Another point relative to skips and gaps is that having a forest inventory robust enough to reflect these skips and gaps over time may be difficult. These installed features occur infrequently in all these prescriptions, yet are considered important ecological features.
- Observationally, all of the 2006 restoration thinning units had a clumpy pretreatment appearance. Visually, the units had a mix of areas that were densely occupied by conifer, as well as areas that were devoid of conifers. Retrospectively, the gaps that were required to be installed in each unit were already occurring naturally.

6.9 Data Summary

A summary of the post-treatment compliance plots is provided in Table 8. In all cases, the average dbh of the thinned unit increased. This increase is because the thinners typically identify the best available tree to be released (not cut), and this best available tree often exhibits a slightly larger diameter than its neighbors. Also, when dealing with areas that have a stem density ranging from a high of 15,833 trees per acre to a low of 1,675 trees per acre one can assume that many of these very dense trees have a dbh that is less than one inch.

When comparing the post treatment trees per acre with the prescribed trees per acre, the numbers are not the same, but in most instances close. These differences can be attributed to natural stand variations found in all stand types.

Table 8: 2006 pre treatment and post treatment tree density and average dbh

unit #	Pre-treatment		Post treatment	
	tpa	avg dbh	tpa	avg dbh
2.1	2580	1.6	157	7.0
2.2	2580	1.6	310	3.7
23	3417	1.5	293	3.5
31	7125	1.1	389	2.8
49.1	11,500	1.0	196	3.9
49.2	3750	1.3	225**	2.4
52	3500	1.4	335	2.3
62	5750	1.0	250	2.0
65	15833	1.0	275	2.1
74	1720	2.5	250	5.7
79	1675	3.1	173*	4.6

* Douglas fir >6” and western red cedar not included in tpa count

****49.2** is a patchy stand: the target of 360 tpa was not realized because of areas poorly populated by trees and not contractor error

7.0 Wrapping it up

2006 restoration thinning combined traditional spacing prescriptions with gaps, skips and lopping treatments. The prescriptions were intended to address spatial heterogeneity, structural heterogeneity, and affect tree growth and understory development. The areas that were thinned have essentially affected the forest development trajectory by moving those treatment areas out of the stem exclusion stage and into the understory reinitiation stage (1990 Oliver, Larson) in one season! Of course, the skips (no cut) will remain in the stem exclusion stage for a long time to come. For the most part, the 2006 thinned areas are lacking larger diameter trees, taller trees and a robust tree species mix. Modeling the thinning prescriptions through time would be helpful for predicting tree development and snag recruitment.

316 acres were considered for treatment in the 2006 restoration thinning program. While forests that develop naturally vary considerably in spatial and structural characteristics, a broad range of measurable target conditions can be identified from old growth data and data collected from younger naturally developing forests. "Patterns of species dominance and changes in stand structures are not the result of obligatory laws which forest stands must follow. While they can be somewhat-but not completely-anticipated, they are simply the result of interactions of plants and are emergent properties of tree interactions." (1990 Oliver and Larson) The staff is optimistic that applying a variety of restoration thinning prescriptions to these young forests (forests that originated within the past four decades) will have a positive effect on the habitat within the collective landscape of the Cedar River Watershed.

7.1 The Future of Slash Treatments

"The understory reinitiation stage generally contains more animal species than does the stem exclusion stage, but fewer than the stand initiation stage. Understory plants generally contain less starch nutrition for animals than those growing in full sunlight. "(1990 Oliver, Larson)

Staff expects a change in wildlife use within the thinned units. Slash may or may not be an impediment to wildlife use. Rodents, whose species mix and populations generally increase during the understory reinitiation stage may not be affected by the thinning slash, for example, while deer and elk may have a difficult time navigating through thinning slash. Lopping and slash pull back were the primary slash treatment prescriptions in 2006, and will be inspected over time for effectiveness.

Effectiveness, in the case of slash treatments, is not clearly defined. For example, is effectiveness determined by the anticipated ease with which an ungulate can traverse through a treatment area (difficult to measure), or by the response of understory plant growth relative to various treatments (measurable), or the change in rodent presence and populations relative to various treatments (difficult to measure, and we have no baseline data) or the change in a treatment area's resistance to wildfire (no ignition experiments allowed in the watershed), or the change in peoples perceptions to thinning related slash (a social/political issue)? Staff will continue to grapple with restoration thinning slash treatments and defining and measuring treatment effectiveness.

8.0 2006 Approach and Beyond

Staff had been utilizing an archaic but functional technique for identifying restoration thinning units since the programs inception in 2000. In 2004 the City received a complex and useful LiDAR data set from King County. The LiDAR data set is proving useful in identifying the candidate pool of restoration thinning units. LiDAR data provides information about average canopy height, which can be used to identify areas that have stands of trees possessing restoration thinning characteristics. More specifically, areas identified through LiDAR data possessing an average canopy height of thirty feet or shorter (<three feet) are being considered for restoration thinning. The benefit of LiDAR is that the data provides average canopy height information for the entire watershed which is a superior technique for identifying restoration thinning candidates.

Landscape level analysis performed during 2005 identified areas across the watershed that possessed important wildlife components. The vision for this landscape level analysis was to identify areas across the

landscape to focus all restoration efforts in; essentially providing a prioritization tool for restoration work. The restoration thinning candidates identified through LiDAR data were given a ranking number based on the candidate's location relative to an area of high wildlife value, thus prioritizing the future restoration thinning units.

Having a ranked by priority candidate pool of restoration thinning units and a consistent annual budget through 2015 should be an effective and economical way to proceed with the restoration thinning program.

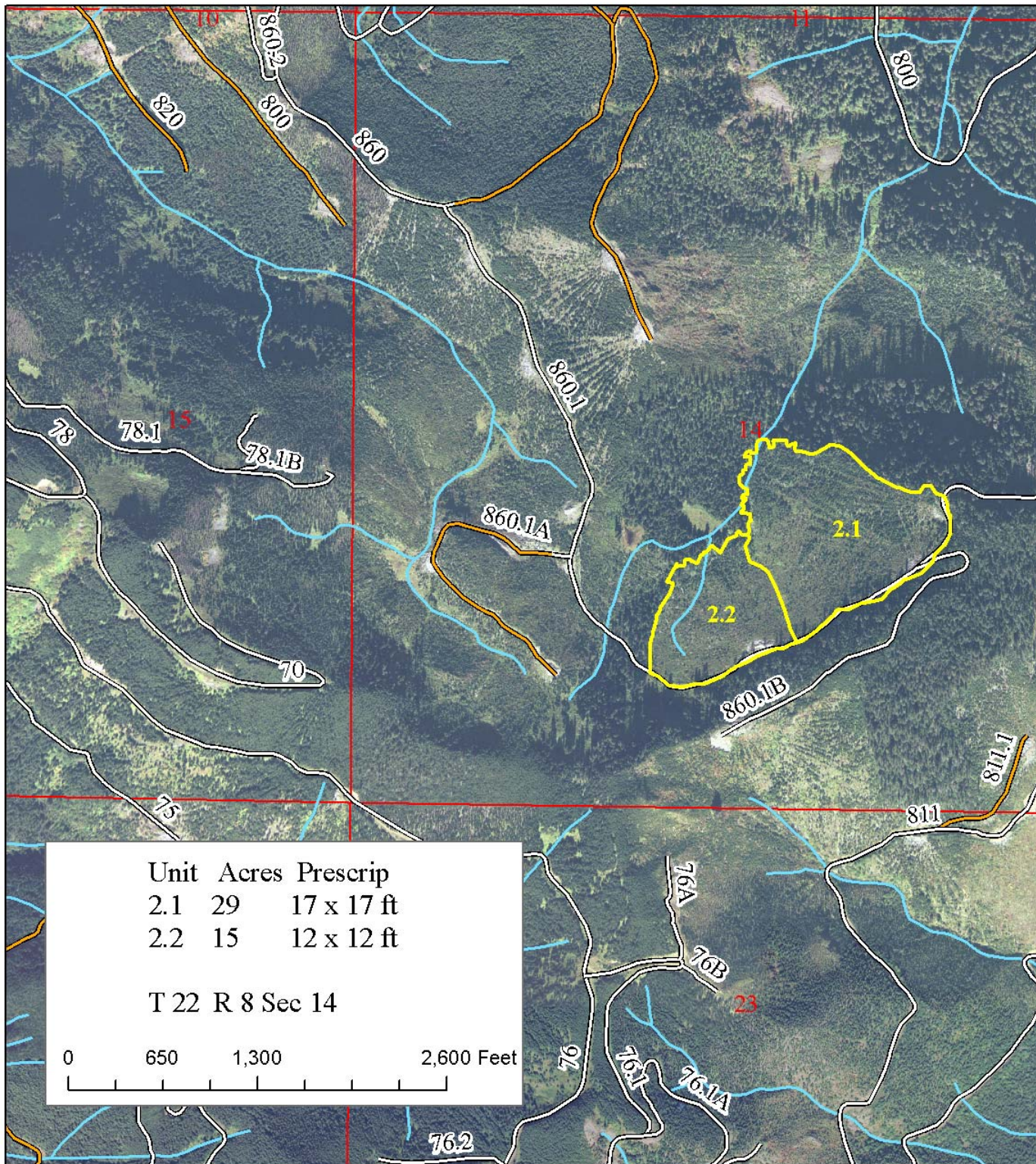
Additional data is being collected in LiDAR derived restoration thinning units for the purpose of characterizing the current stand conditions. Data collection protocol is included in Appendix C. This data will be used to design restoration thinning prescriptions. The vision is to collect data from a sufficient number of future units for the purpose of improving the efficiency of the program without jeopardizing the complexities of restoration.

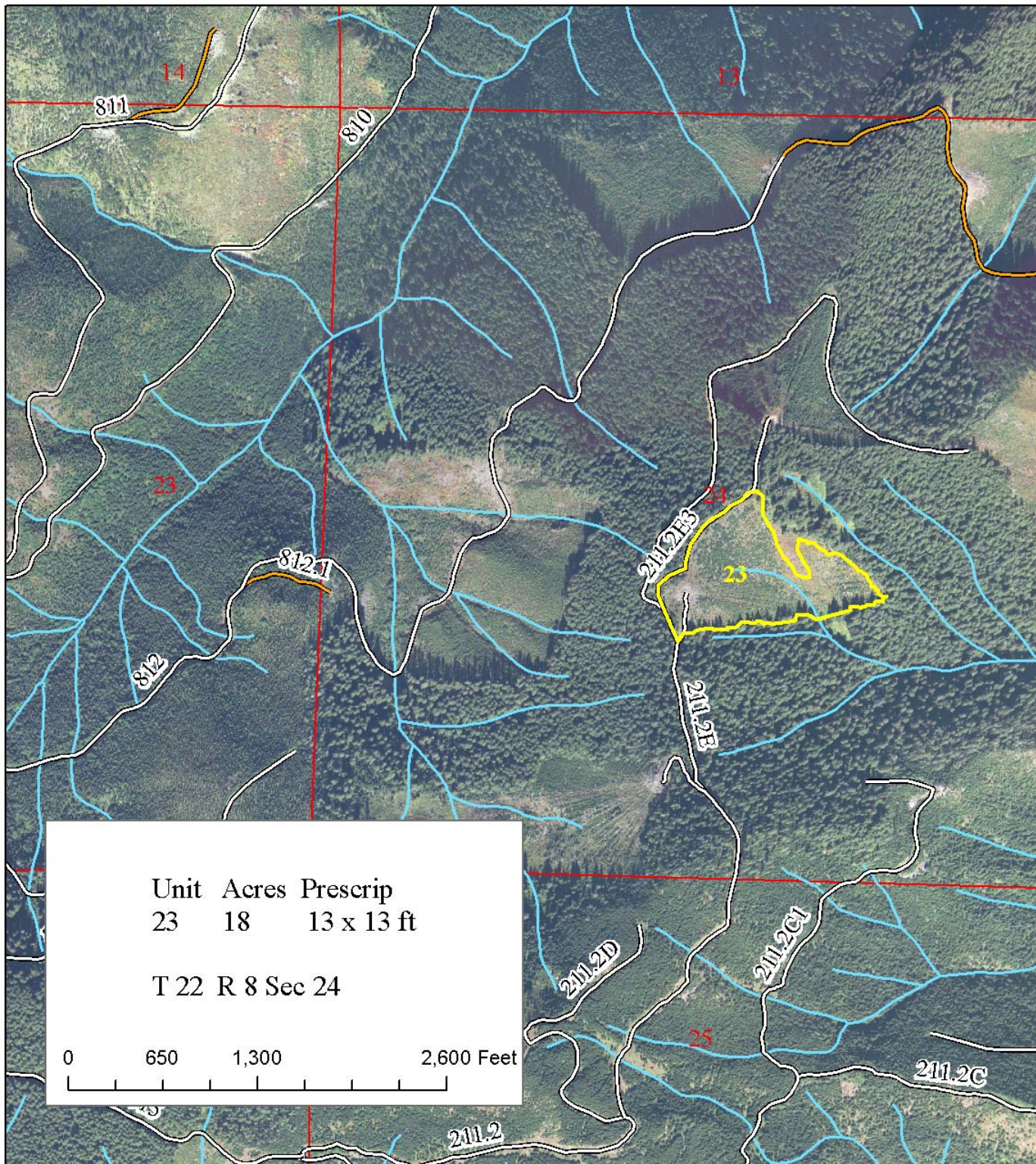
Citations

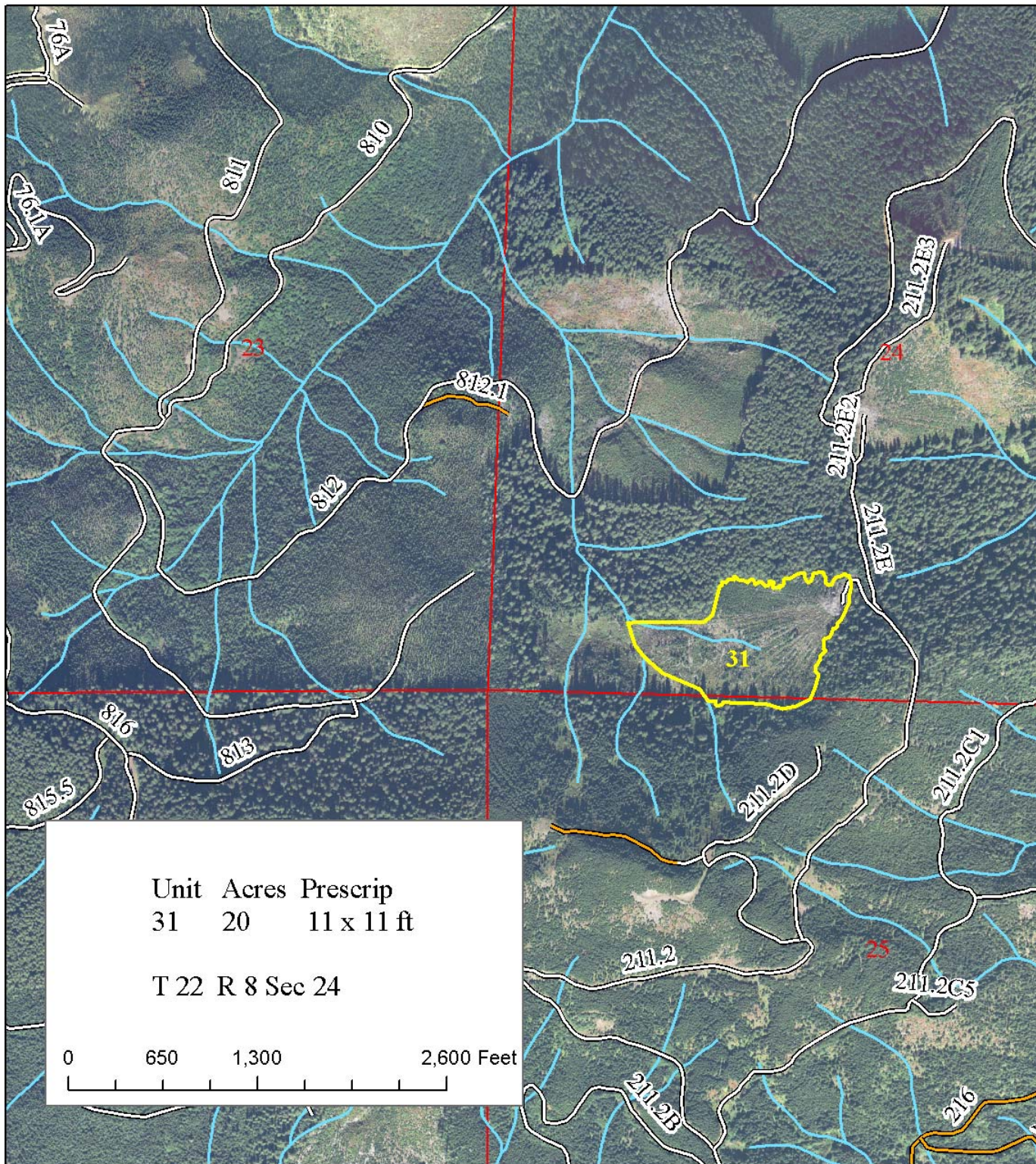
Oliver, C.D., and B.C. Larson. 1990. Forest Stand Dynamics, McGraw-Hill, Inc. 467 pp

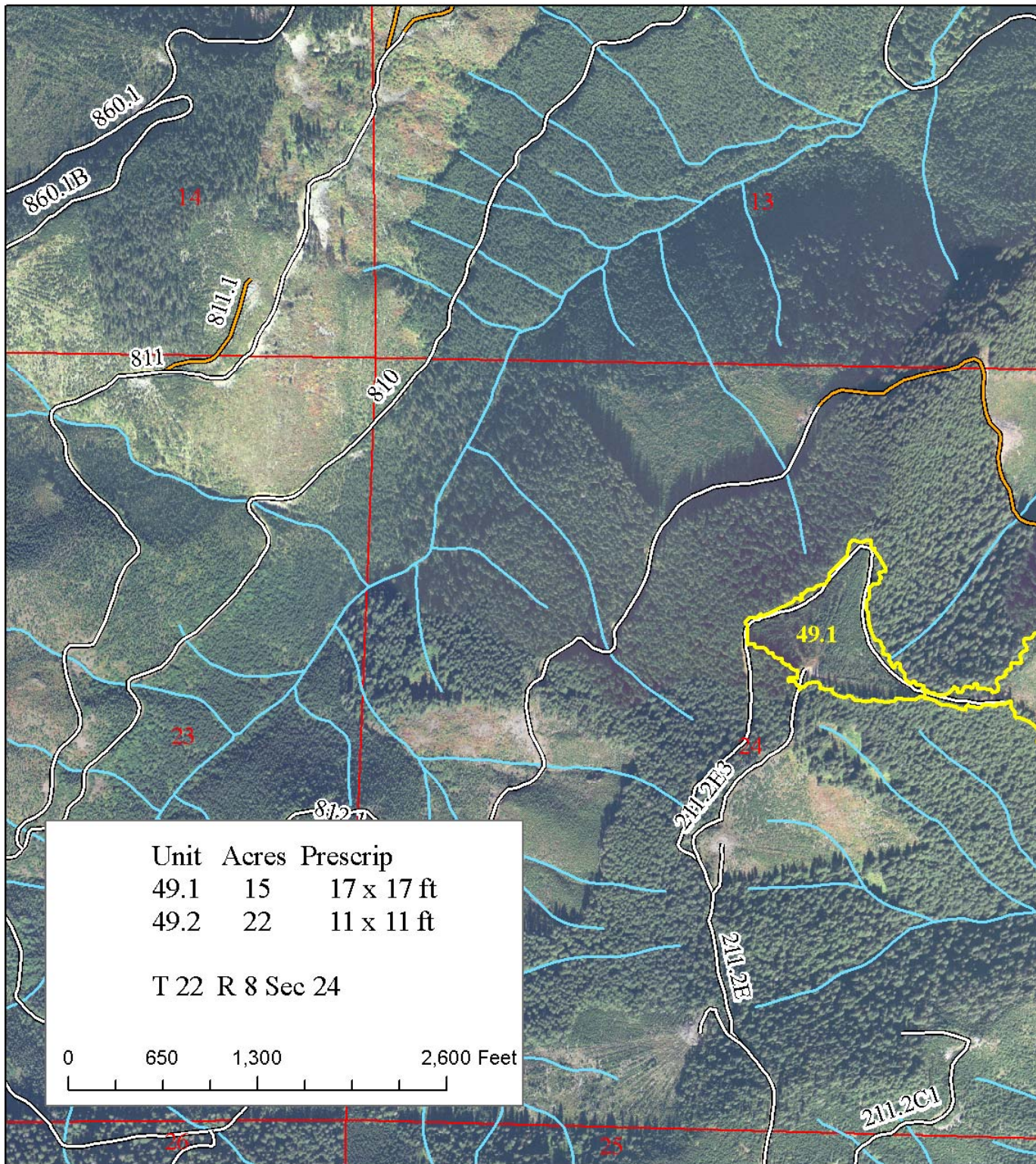
Silvics of North American Tree Species

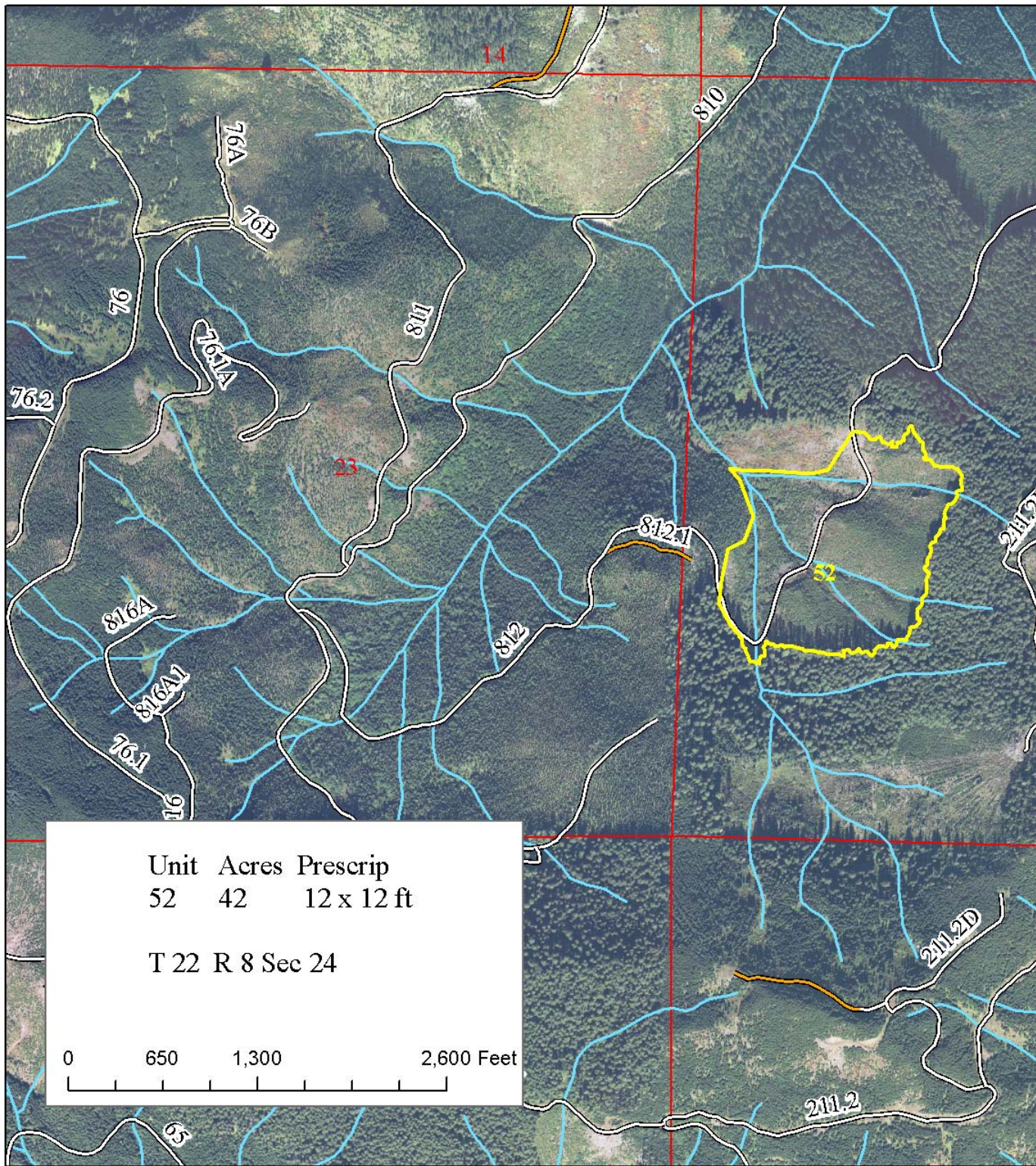
Appendix A: 2006 Unit Maps

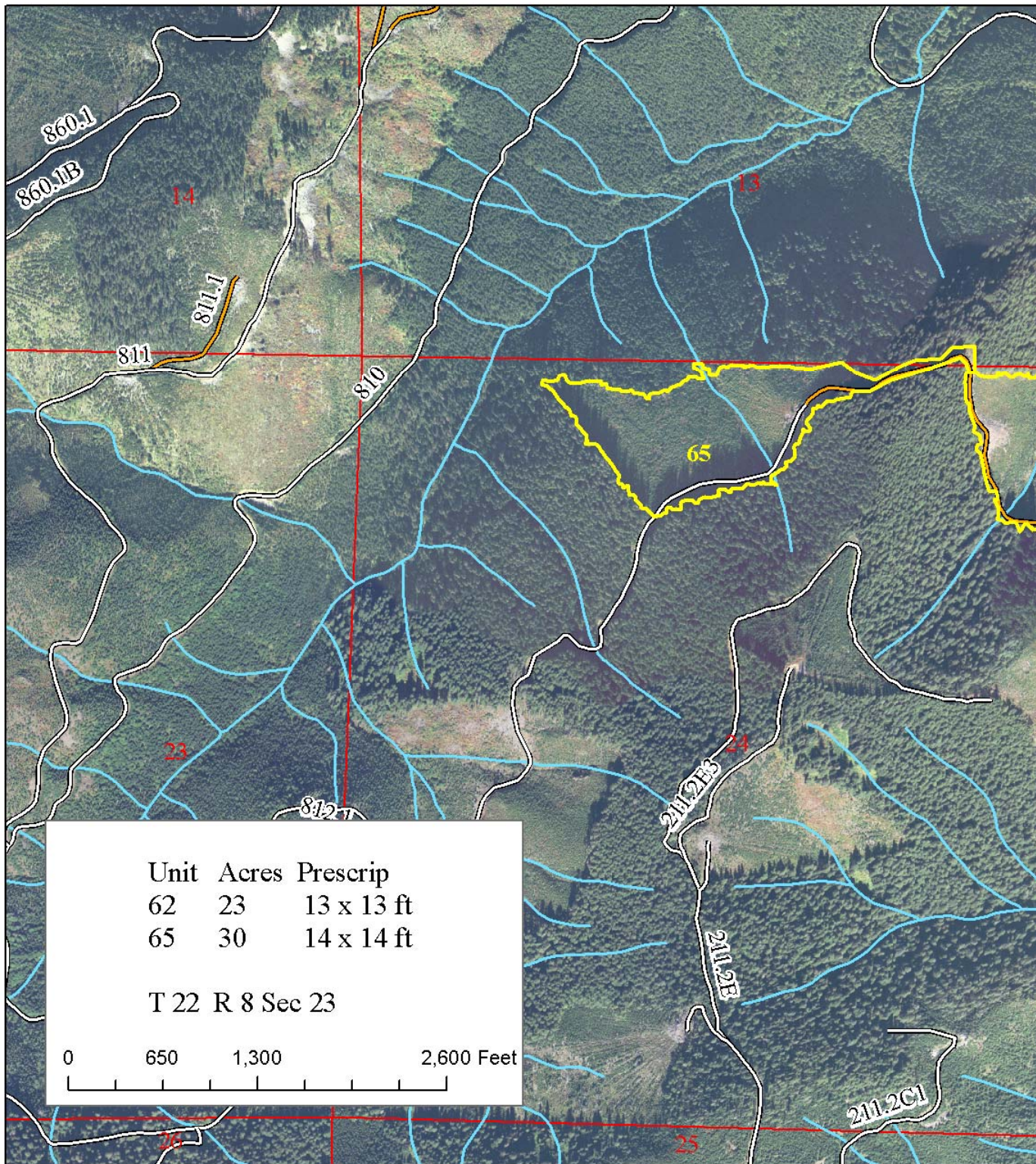


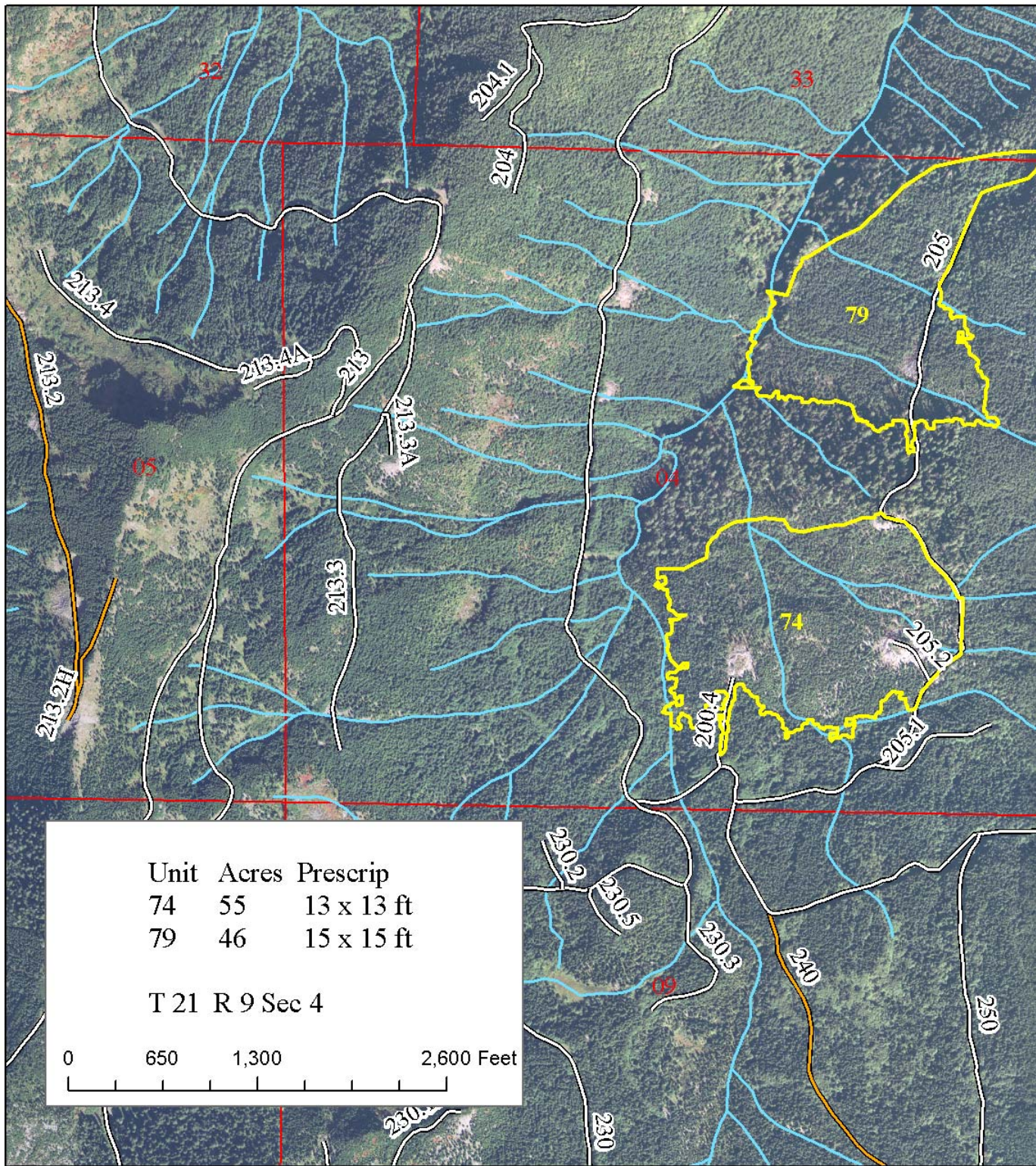












Appendix B: City of Seattle Watershed Management Division Restoration Thinning
Contract Specifications Year 2006

CITY OF SEATTLE
WATERSHED MANAGEMENT DIVISION
RESTORATION THINNING
CONTRACT SPECIFICATIONS
YEAR 2006
CEDAR RIVER WATERSHED
NORTH BEND, WA

Note: It is the Contractor's responsibility to read the entire contract contained herein and to communicate the details of the Contract Specifications to his foremen and to provide a copy to them.

This is not a prevailing wage contract - Federal and state minimum wage laws apply.

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SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

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UNIT #	PRESCRIPTION	ACRES	PER ACRE BID	TOTAL UNIT BID
2.1 & 2.2	<ul style="list-style-type: none">-Two sub-units comprise this unit: unit 2.1 east and unit 2.2 west-Thin unit 2.1 to 17x17 foot spacing (151 trees per acre)-Thin unit 2.2 to 12x12 foot spacing (302 trees per acre)-Cut primarily silver fir and western hemlock-Keep all thinning related slash away from streams-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)	44		
2.1 & 2.2	<ul style="list-style-type: none">-Lop entire unit leaving thinning slash no greater than 18" from forest floor-Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash	44		

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

(Page 2 of 7)

23	<ul style="list-style-type: none"> -Thin unit 23 to 13x13 foot spacing (258 trees per acre) -Cut primarily silver fir and western hemlock -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	18		
23	<ul style="list-style-type: none"> -Lop entire unit leaving thinning slash no greater than 18" from forest floor -Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash 	18		
31	<ul style="list-style-type: none"> -Thin unit to 11x11 foot spacing (360 trees per acre) -Cut primarily silver fir and western hemlock -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	20		
31	<ul style="list-style-type: none"> -Lop entire unit leaving thinning slash no greater than 18" from forest floor -Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash 	20		

Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 3 of 7)*

UNIT #	PRESCRIPTION	ACRES	PER ACRE BID	TOTAL UNIT BID
49.1	-Thin unit to 17x17 foot spacing (151 trees per acre) -Cut primarily silver fir and western hemlock	15		
49.1	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	15		
49.2 (note: this unit is only accessible from the 211.2E3 road; the 812 road at the bottom has been reclaimed.)	-Thin unit to 11x11 foot spacing (360 trees per acre) -Cut primarily silver fir and hemlock -Thin road right of way between unit 49.1 and 49.2 -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)	22		
49.2	-Lop entire unit leaving thinning slash no greater than 18" from forest floor -Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash	22		

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

(Page 4 of 7)

52	<ul style="list-style-type: none"> -Thin unit to 12x12 foot spacing (302 trees per acre) -Cut primarily silver fir and western hemlock -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall -If no Douglas fir, or western red cedar present thin the alder to 12x12 foot spacing -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	42		
52	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	42		
62 (note: this unit is only accessible by hiking into it)	<ul style="list-style-type: none"> -Thin unit to 13x13 foot spacing (258 trees per acre) -Prioritize Douglas fir and noble fir as leave trees -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall in the unit -Keep all thinning related slash away from stream -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	23		
62	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	23		

Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 5 of 7)*

UNIT #	PRESCRIPTION	ACRES	PER ACRE BID	TOTAL UNIT BID
65	<ul style="list-style-type: none">-Thin unit to 14x14 foot spacing (222 trees per acre)-Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall in the unit-Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall on the decommissioned road leading from the end of the drivable 812 road into unit 62 (13x13 foot release)-Maintain a slash free path for the purpose of human travel on this decommissioned road-Keep all thinning related slash away from stream-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)	30		
65	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	30		

Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 6 of 7)*

UNIT #	PRESCRIPTION	ACRES	PER ACRE BID	TOTAL UNIT BID
74	<ul style="list-style-type: none">-Thin unit to 13x13 foot spacing (258 trees per acre)-Cut primarily silver fir and western hemlock-Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall in the unit or on or adjacent to the 200.4 or 205.2 road-Keep all thinning related slash away from streams and open areas-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 8x8 spacing-No trees may be cut within an inner gorge. Trees above the upper break of the inner gorge that are within 10 feet of the upper break will be thinned to 10x10 foot spacing.-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams	55		
74	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	55		

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 7 of 7)*

79	<ul style="list-style-type: none">-Thin unit to 15x15 foot spacing (194 trees per acre)-Cut no Douglas fir >6 inches dbh-Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall (15x15 foot spacing)-Keep all thinning related slash away from streams and open areas-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)-No trees may be cut within an inner gorge. Trees above the upper break of the inner gorge that are within 10 feet of the upper break will be thinned to 10x10 foot spacing-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams	46		
79	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	46		
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Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

SECTION B: GENERAL SPECIFICATIONS, TECHNICAL SPECIFICATIONS, MEASUREMENT AND PAYMENT

B 1.0 General Specifications

B 1.1 *Scope of Contract*

This Contract requires tree thinning, slash treatment, release, and related work in compliance with its terms, specifications and provisions. Work includes furnishing labor, equipment, supervision, transportation, operating supplies, and incidentals except those items, if any, listed as City furnished property.

B 1.2 *Location and Description*

- A. Location: The locations of the worksites are shown on the Unit Maps that are part of this contract. All areas are within the Cedar River Municipal Watershed.
- B. Boundaries - All areas are signed at conspicuous locations on access roads and along unit boundaries, using fluorescent pink tags, fluorescent pink flagging, fluorescent lime green flagging marked "Silviculture Boundary", and/or "Boundary of Contract Area" signs, unless they are obviously defined by physical features, such as streams, roads, timber type boundaries, etc., which are shown as boundaries on the Unit Maps.
- C. Description - The Bid Information Worksheet, contained in Section A of this contract, includes prescription information related to the contract units. The Unit Maps show physical features of the units. The information contained in the worksheet and maps shall be considered part of the technical specifications.
- D. Accessibility
 - 1. Work areas may be reached by City roads that are accessible by standard two wheel drive pickup during normal operating seasons. The roads are gravel surfaced and may become slick. Vehicles shall not operate off roads...
 - 2. Inaccessibility due to snow, fallen trees, slides or washouts on roads may or may not be corrected at City's option. If road access is blocked, the City may: (a) provide an alternate access route; (b) delete the inaccessible unit(s) or, (c) substitute similar unit(s).
 - 3. Roads shown on unit maps indicate access to units and are not meant to suggest the roads are open beyond for any further travel.

B 1.3 *City - Furnished Property*

- A. Inspection forms will be furnished to the Contractor under this contract.
- B. The City will provide a trailer mounted chemical toilet and service it as needed. The Contractor must have a compatible trailer hitch on one or more of their vehicles for moving the toilet to daily work areas.

B 1.4 Salvageable Material
None available

B 1.5 Motorized Equipment
Use of motorized equipment other than hand held equipment such as power saws and brush cutters will not be permitted off designated roads in the project area without written approval of the City's Project Manager.

B 1.6 Progression of Work
The Contractor shall complete all required work on each unit before starting on a new unit, unless otherwise approved by the City's Project Manager. Changing of crews shall be minimized within a unit and shall be subject to the City's advance approval.

B 1.7 Definition of Technical Specifications Terms

- A. Thinning - The cutting of trees in excess of those to be retained for the purpose of forest management.
- B. Girdling - A cut, or series of cuts, made through the bark and cambium tissue, completely encircling the tree trunk, for the purpose of killing the tree. *All girdling cuts must be below any live branch.* Girdling cuts must not go further than one half inch into the tree from the cambium layer in order to avoid unnecessarily weakening the girdled tree.
- C. dbh (diameter breast height) Diameter of the trunk measured at a point 4-1/2 feet above the ground on the uphill side of the tree.
- D. Spacing - The horizontal distance from the center of one leave tree to the center of the next nearest leave tree.
- E. Average spacing - The average of the distance between all leave trees necessary to provide the desired number of leave trees per acre.
- F. Manual release - The cutting of vegetation within a specified radius around a leave tree.
- G. Leave tree - Any tree that is selected or required to be left standing as provided in the specifications.
- H. Excess tree - A tree which the Contractor, contrary to the specifications, has left uncut, has not completely severed from the stump, has left as a hang-up tree, has left with a stump exceeding the specified maximum height, or has left live limbs on stump
- I. Surplus tree - Any tree over 1 foot in height, which is required to be killed by cutting as provided in the prescriptions.

- J. Damage (defect) - Includes any defect or deformity of a tree resulting from such agents as wind, snow, animals, insects, disease, or equipment and evidenced by such things as dead or broken tops or trunks, crooks, and deep scars.
- K. Deficient trees - Those trees cut which should have been left to maintain average spacing requirements, or trees not selected according to the prescriptions, or leave trees that are excessively damaged by the thinning operation.
- L. Hang-up tree - Any cut tree that leans against or is suspended above ground level by a leave tree.
- M. Slash - Any vegetation that is cut by the Contractor
- N. Pull back - Pulling back and scattering slash by hand methods in thinned unit as indicated by prescriptions and/or unit maps
- O. Schedule of Units- Same as Section A, Bid Information Sheet, wherein the contract unit prices are entered
- P. Cull tree - Any tree with major damage or disease
- Q. Inner gorge – An inner gorge is a geomorphic feature identified as that area of stream bank immediately adjacent to the stream channel having a side slope of generally over 65 percent, and located below the first break in slope above the stream channel.
- R. Lopping – Lopping is the treatment of thinning slash so that the limbs of cut trees are cut from the stem to allow the stem to make contact with the ground or other slash that is in contact with the ground and to remove the limbs sticking up from the stem so that slash lies as flat and as compact as possible. Lopping includes bucking the stem wherever the tree crosses another stem and at topographical breaks so that the stem lies in close contact to the ground or other compacted slash that is in contact with the ground, unless specified otherwise.
- S. Gaps – A gap is a designated area within the thinning unit in which all the trees are cut, essentially leaving a treeless hole within the boundary of the thinning unit. The prescription for gaps can require that all the trees be cut within a gap or that a specified number of trees are left within the gap.

B 2.0 Technical Specifications

B 2.1 Selection of Leave Trees

- A. Leave trees shall be selected by the Contractor except that the City may mark additional individual leave trees.
- B. Leave all conifer and hardwood trees which exceed the maximum dbh limit specified, regardless of the resulting spacing. (See B2.1A)

- C. Selection of leave tree species will be based on leave trees that are under-represented (not the dominant species) in the unit. Both conifers and hardwoods are acceptable leave trees.
- D. The average number of trees per acre shall not be materially increased or decreased from the average number of trees per acre specified for the spacing required.
- E. All hardwood and shrub species, unless otherwise specified in the prescriptions will be retained.
- F. All western red cedar will be retained.

B 2.2 Cutting Requirements

- A. Maximum dbh cut limit - Cut surplus conifers up to maximum dbh cut limit identified in prescriptions on Bid Information Worksheet (section A). Within the specified Unit, trees that meet or exceed the minimum dbh will not be cut. These dbh limit leave trees will not be included in tree spacing plots. It is anticipated that where the 'bigger' trees exist in a unit will result in denser spacing.
- B. Stump Height – Removal of Live Limbs – All cut trees over 1.0 foot tall shall be cut below the lowest live limb, except when prevented by natural obstacles, in which case any live limbs below the cutting point shall be removed. Trees shall be completely severed from the stump. Stump height shall not exceed 6.0 inches above ground level or 3.0 inches above natural obstacles. When ground vegetation conceals trees less than 2.0 feet tall the inspector may disregard these trees if considered impractical to find.
- C. Buffers for Streams, Wetlands and Meadows – Within all units, no trees may be cut within an inner gorge. Trees above the upper break of the inner gorge that are within 25 feet of the upper break will be thinned to 10x10 foot spacing.

In addition, for all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any flowing stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams.

No trees or shrubs are to be cut within any herbaceous (i.e., grass, forb, sedge) or shrub (for example, willow, red-osier dogwood, sweet gale) dominated wetland or meadow.

- D. Felling and Removal - Cut trees shall be felled away from unit boundaries, roads, trails, established land corners, other physical improvements, streams, and wetlands. Any trees falling on such areas shall be removed and treated as specified below:
 - 1. If trees are felled across telephone or electrical lines, the Contractor shall immediately notify the utility company, then the Project Manager. Removal of

these trees shall be performed at the Contractor's expense, and as directed by the utility company.

2. Removal of felled trees from the road running surface, trails and streams shall be accomplished daily. The running surface, cut slopes, culvert catch basins, and ditches are considered portions of the road for slash disposal purposes. Areas within 10 feet horizontal distance of stream bank full width are considered part of the stream for this requirement. Trees shall not be felled into inner gorges.
3. Removal of felled trees shall be accomplished prior to acceptance of the sub item for payments.

E. Weed Control – All Scot's broom within thinning units must be cut.

B 2.3 Slash Treatment

Roadside slash pull back is required on all units. The running surface, cut slopes, culvert catch basins, and ditch lines are considered part of the road and slash must be pulled back 2 feet from these portions of the roads and scattered into the unit. Slash hanging over the road must be treated the same as slash on the road.

Lopping – The price of lopping is entered as a separate bid item and will be awarded to the same vendor that thins the unit. Lopping is described in B 1.7 'R'

B2.4 Chain saw operations

Chain saws are required to operate with only biodegradable bar-oil.

B 3.0 Measurements and Payment

B 3.1 Measurement

The acres were measured on the horizontal plane within the established boundaries using a G.I.S. and orthophotos. The Contractor agrees to accept these stated acres as final and submits unit bid prices accordingly. There is no provision for re-measurement or change of stated acres.

B 3.2 Basis of Payment

A. Calculation of Payment of Thinning and Release:

1. The City will calculate the pay rate on a contract unit basis.
2. Contract item pay rate will be made for thinning quality on the following basis:
 - a. When the percent of satisfactory work is 90 percent or greater, payment will be made at the contract unit price.

- b. When the percent of satisfactory work is below 90 percent, payment will be made at the actual inspection percent multiplied by the contract unit price.
- B. Roadside slash pullback treatment will be considered incidental to thinning and no separate payment will be made. A unit will not be considered complete for payment purposes until all slash treatment is completed. Slash treatment and thinning operations shall be done concurrently. Contractor will not be allowed to proceed to another unit until the slash treatment is completed.

SECTION C: INSPECTION AND ACCEPTANCE

C 1.0 Inspection of Services

C 1.1 Services

“Services”, as used in this clause includes services performed, workmanship, and material furnished or utilized in the performance of services.

C 1.2 Inspection System

The Contractor shall provide and maintain an inspection system acceptable to the City covering the services under this contract. A complete record of all inspection work performed by the Contractor shall be maintained and made available to the City during contract performance.

C 1.3 Right to Inspect

The City has the right to inspect and test all services called for by the contract, to the extent practicable at all times and places during the term of the contract. The City shall perform inspections and tests in a manner that will not unduly delay the work.

C 1.4 Rework to Meet Contract Requirements

If any of the services do not conform to contract requirements, the City may require the Contractor to perform the services again in conformity with contract requirements, at no increase in contract amount. When the defects in services cannot be corrected by re-performance, the City may (1) require the Contractor to take necessary action to ensure that future performance conforms to contract requirements and/or (2) reduce the contract price to reflect the reduced value of the services performed.

C 1.5 Costs of Rework

If the Contractor fails to promptly perform the services again or to take the necessary action to ensure future performance in conformity with the contract requirements, the City may (1) by contract or otherwise, perform the services and charge to the Contractor any cost incurred by the City that is directly related to the performance of such service and/or (2) terminate the contract for Default.

C 2.0 Standards for Contractor Quality Control (Self-Inspection Plan)

C 2.1 Contractor's Quality Control

The Contractor has full responsibility for quality control under this contract.

C 2.2 Acceptable Inspection System

The inspection procedure specified in (C-4) constitutes the only acceptable inspection system under this contract.

C 3.0 Qualifications of Contractor's Inspector

C 3.1 Qualified Foremen

The Contractor shall provide qualified foremen who are proficient in reading, writing, and speaking English. If the Contractor fails to do this, the Project Manager may terminate the contract.

C 4.0 Inspection

C 4.1 Contractor Inspection

The Contractor shall make inspections of all work to monitor work quality and compliance with contract specifications.

C 4.2 Inspection Procedure

- A. Inspection for acceptance and payment will involve inspection of a series of plots uniformly distributed over the entire unit, sufficient to yield at least a 0.5 percent sample (a 0.5% sample consists of 1 - 1/50th acre plot for every 4 acres) with a minimum of 10 plots measured for any unit. Plot size will be 1/50th acre for all items. The radius for a 1/50th acre plot is 16.7 feet, horizontal distance. Horizontal correction for slope will be necessary.
- B. Each plot will be examined and the items listed below shall be recorded on forms provided.
 1. Number of leave trees that should have been retained.
 2. Number of trees that were retained.
 3. Number of satisfactory leave trees retained.
 4. Number of deficient trees (uncorrectable work).
 5. Number of excess trees (correctable work).
- C. Upon inspection of all plots for a unit, the quality of thinning shall be calculated as follows:

$$1.00 - \left[\frac{\text{No. of deficient trees} + \text{No. of excess trees}}{\text{No. of leave trees that should have been left}} \right] \times 100 = \text{Quality \%}$$

The quality % is calculated separately by each contract item and rounded to the nearest 0.1% for pay purposes

The City's inspection results will be used for determining payment in accordance with this section.

C 5.0 Re-inspection Upon Contractor's Request

C 5.1 Re-Inspection Requests

Requests for re-inspection, if any, must be made in writing within five days after receipt of the City's inspection results.

C 5.2 Re-Inspection Costs

If the difference between the City's re-inspection results and the City's original inspection results are within 5 percent, the Contractor will pay for re-inspection costs. These costs may include wages and vehicle mileage, as based on City cost tables.

C 5.3 City Payment of Re-Inspection Costs

If the difference is greater than 5 percent, the City will pay for the actual re-inspection costs.

C 6.0 Inspection of Unsatisfactory Thinning and Release and Rework

C 6.1 Correcting Unsatisfactory Work

If the percentage of satisfactory work falls below 80 percent, the City will immediately notify the Contractor. If the unsatisfactory work is due to correctable work (i.e., excess trees, cutting methods, brush, and slash), rework will be required. If it is due to non-correctable work (i.e. over-cutting, damage, and leave tree selection) payment will be made at the percentage rate multiplied by the contract unit price. If the quality of future work is not raised above the 80 percent minimum acceptable standard within two workdays after receipt of notice from the City of unsatisfactory work, the Contractor's right to proceed may be suspended for noncompliance. Repeated failure to perform work at or above 80 percent acceptable work may also be considered reason for contract termination.

C6.2 Re-Inspecting Corrected Work

Re-inspection after rework will be made in the same manner as the first inspection but on different plot lines and plots. The Contractor shall pay for inspections necessitated as a result of the rework. This charge will be subtracted from the amount due for thinning.

SECTION D: COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK

D 1. 0 Scheduling of Work

D 1.1 Performance

The Contractor shall be required to (a) commence work under this contract within ten (10) calendar days after the date the Contractor receives notice to proceed, (b) do the work diligently, and (c) complete the entire work no later than October 15 of the year of the contract. Failure of the Contractor to pick up certified mail will not be considered an excusable delay. The time stated for completion shall include final cleanup of the premises.

D 1.2 Notice to Proceed

The City will issue a Notice to Proceed on each unit as soon as conditions are favorable.

D 1.3 Sequence of Work Performance

The City reserves the right to select the sequence of units to be treated. They will be selected to permit continuous progression to adjacent units in so far as possible, dependent upon weather, accessibility, and other factors, which may cause earlier or later beginning or ending dates.

Contract operations shall be conducted on regular Monday through Friday work days. Work on weekends or designated City holidays may be permitted with permission from the City. The Contractor shall notify the City's Project Manager in advance of any changes in the established daily work schedule.

SECTION E: CONTRACT ADMINISTRATION

E 1.0 Definitions of Contract Administration Terms

A. Project Manager - The person executing this contract on behalf of the City including any duly appointed successor and authorized representatives acting within the limits of their authority.

B. Inspector - The person(s) appointed by the Project Manager to conduct the document inspections according to contract specifications and provisions. The inspector's authorities are strictly limited, not to exceed the authority to issue to the Contractor a Notice of Non-compliance (see below).

C. Change Order - An order issued to the Contractor by the Project Manager, pursuant to "Changes" in this contract, requiring work to be performed within the general scope of the contract.

D. Work Order - An order written by the Inspector, which directs the Contractor to correct deficient performance. May also be used to document acceptable completion of work units and to approve starting on additional work units.

E. Notice of Noncompliance - A written notice from the City which documents, for the Contractor's attention, specific performance deficiencies.

F. Contract Unit - A pay item designated on the bid schedule and described by a specification.

G. Specifications - That portion of the contract comprising a description of the general and technical requirements for materials, products or services to be furnished under the contract.

E 2.0 Project Manager

The Project Manager will provide on-the-ground administration of the contract.

E 3.0 Pre-work Meeting

A meeting will be requested by the City prior to commencement of work. The Contractor shall meet with the Project Manager to discuss contract terms and work performance requirements, work progress schedule, and fire prevention and suppression plans. The meeting will be held at Cedar Falls at a time and date to be determined by the Project Manager.

E 4.0 Supervision by the Contractor

At all times during performance of this contract and until the work is completed and accepted, the Contractor shall directly supervise the work or assign and have on the work site a competent foreman whose work is satisfactory to the Project Manager and who has authority to act for the Contractor. *In the event that work is occurring simultaneously at different locations, each work site must have its own competent foreman.*

E 5.0 Schedules for Service Contracts

The Contractor shall, within 5 days from receipt of a request from the Project Manager, submit a time chart or schedule of proposed progress to ensure completion of the work within the time set forth in the contract. If the Contractor's progress falls behind that scheduled, the Contractor shall take such action as necessary to improve his progress. In addition, the Project Manager may require the Contractor to submit a revised schedule and proposed plan of work to ensure completion of the work within the time set forth in the contract.

SECTION F: FIRE PREVENTION AND CONTROL

F 1.0 Fire and Sanitation Regulations

The Contractor shall be governed, in addition to any fire plan contained in the contract, by the following:

- A. Contractor's Responsibility in Fighting Own Fires. The Contractor shall immediately extinguish without expense to the City all fires on or in the vicinity of the project which are caused by him or his employees whether set directly or indirectly as a result of the work on this project. The Contractor may be held liable for all damages resulting from fires set or caused by his employees, or resulting from the execution of this contract.

If the amount and character of labor, subsistence, supplies, and transportation which the Contractor is in a position to furnish promptly for fire suppression proves inadequate, the City is authorized to procure such items and services as it may deem necessary and charge associated costs to the Contractor.

- B. Use of Contractor's Employees to Fight Other Fires. For the purpose of fighting forest fires on or in the vicinity of the project that are not caused by the Contractor or his employees, the Contractor, when requested by the City, shall place his own employees and equipment temporarily at the disposal of the City. The City will make payment for

such services at not less than the current rate for fire-fighting services established by the City in the area concerned.

1. Any employees and equipment furnished will be relieved from fire fighting as soon as the City finds that it is practicable to employ other labor and equipment adequate for the protection of the area.
2. An equitable adjustment in contract time may be made for this activity if necessary.

F 2.0 Operations

The Contractor shall conduct all operations for the execution of this contract in accord with State of Washington Forest Protection Laws, title 76.04 RCW and Chapter 332-24 WAC and all other laws. The City of Seattle and the State of Washington Department of Natural Resources will administer the fire regulations. The listing of forest protection laws above does not and is not intended to relieve the Contractor in any way from compliance with State fire laws covering fire prevention and suppression equipment applicable to the operations under this agreement. In addition to the Washington State fire regulations, the Contractor shall measure relative humidity and immediately shut down all contract operations when the relative humidity drops below 30%.

The Contractor must provide a sling psychrometer and tables to calculate the relative humidity.

The Contractor must provide a *reliable*, on the job communication system (i.e. wireless phone) at each operating work site capable of contacting the City office at Cedar Falls and the Washington State Department of Natural Resources within 15 minutes of the detection of a fire or other emergency.

The Contractor must have a DNR approved fire toolbox and water supply on site. All spark emitting equipment must meet State regulations. The Contractor must provide working fire extinguishers for Foreman and Crew as required by State regulations. Contractor must abide by all Industrial Fire Precaution Levels.

F 3.0 Use of Premises

A. Abandoned Property - The Contractor agrees that property owned or which was in the possession of the Contractor, his employees, subcontractors, or agents and remaining on City land for more than 30 days after the termination of this Agreement, may be removed by the City at the Contractor's expense.

B. Sanitation Requirements:

1. The Contractor must provide a garbage container in a convenient location at all work sites. The Contractor shall pick up and remove all litter daily in a manner satisfactory to the City.
2. The City will provide and service one approved chemical toilet. The chemical toilet will be trailer mounted for ease in moving to ongoing work areas and servicing areas. The toilet will have a "cover plug" which must be used when transporting between work sites and will also have leveling jacks. The Contractor's towing vehicle must have a compatible 2"x2" trailer hitch receptacle to move the trailer-mounted toilet to daily work areas. If the Contractor chooses to work in more than one area at a time, the Contractor will be required to provide an approved chemical toilet for each additional work areas. Such toilets shall be pumped and cleaned at the Contractor's expense at a minimum of once every 50 person days of use.
3. Chemical toilets and garbage containers shall be placed on flat surfaces at convenient locations and adequately protected against turnover or upset. Location of toilets and garbage containers will be subject to approval of the City's Project Manager.

C. Registration and Access - All persons entering the watershed shall be registered with Seattle Public Utilities. Access throughout the existing watershed gates for contract purposes shall be by use of security system provided by the City. A City vehicle access permit must be obtained and displayed in each vehicle using the Cedar River Watershed road system. Operation of vehicles on watershed roads shall be in accord with standard rules of the road

Keys, gate pass card, permits, and permit holders checked out to the contractor are accountable property and must be returned to the City upon completion of the contract. Final payment will be held until this is done.

D. Camping Restrictions - The Cedar River Watershed is a controlled watershed that is closed to public entry. Camping is prohibited within the boundaries of the watershed, including Rattlesnake Lake Park and the Christmas Lake area.

E. Spill Kit – The City will provide one oil containment spill kit and oil absorbent pads. The oil absorbent pads will be used under all equipment when being fueled and whenever there is a potential for petroleum based product spills. Care will be taken by the Contractor to prevent petroleum based product spills. If a spill occurs, the Contractor will use the oil containment spill kit to control the spread and clean up the spill. The Project Manger will be notified immediately of any spills.

IN WITNESS THEREOF, the parties have executed this Agreement by having their representatives affix their signatures.

CONTRACTOR

SEATTLE WATER

BY _____
Signature Date

BY _____
Signature Date

Name (Type or Print)

Name (Type or Print)

Title

Title

Appendix C: Unit Prescriptions from the contract

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

(Page 1 of 7)

UNIT #	PRESCRIPTION	ACRES	PER ACR
2.1 & 2.2	<ul style="list-style-type: none"> -Two sub-units comprise this unit: unit 2.1 east and unit 2.2 west -Thin unit 2.1 to 17x17 foot spacing (151 trees per acre) -Thin unit 2.2 to 12x12 foot spacing (302 trees per acre) -Cut primarily silver fir and western hemlock -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	44	
2.1 & 2.2	<ul style="list-style-type: none"> -Lop entire unit leaving thinning slash no greater than 18" from forest floor -Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash 	44	

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 2 of 7)*

23	<ul style="list-style-type: none">-Thin unit 23 to 13x13 foot spacing (258 trees per acre)-Cut primarily silver fir and western hemlock-Keep all thinning related slash away from streams-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)	18	
23	<ul style="list-style-type: none">-Lop entire unit leaving thinning slash no greater than 18" from forest floor-Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash	18	
31	<ul style="list-style-type: none">-Thin unit to 11x11 foot spacing (360 trees per acre)-Cut primarily silver fir and western hemlock-Keep all thinning related slash away from streams-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)	20	
31	<ul style="list-style-type: none">-Lop entire unit leaving thinning slash no greater than 18" from forest floor-Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash	20	

Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 3 of 7)*

UNIT #	PRESCRIPTION	ACRES	PER ACR
49.1	-Thin unit to 17x17 foot spacing (151 trees per acre) -Cut primarily silver fir and western hemlock	15	
49.1	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	15	
49.2 (note: this unit is only accessible from the 211.2E3 road; the 812 road at the bottom has been reclaimed.)	-Thin unit to 11x11 foot spacing (360 trees per acre) -Cut primarily silver fir and hemlock -Thin road right of way between unit 49.1 and 49.2 -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit)	22	
49.2	-Lop entire unit leaving thinning slash no greater than 18" from forest floor -Create a 50 foot slash free zone adjacent to all old growth edges by piling thinning slash outside this 50' slash free zone; this piled slash will resemble separate piles of slash and not a long impenetrable wind-row of slash	22	

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

(Page 4 of 7)

52	<ul style="list-style-type: none"> -Thin unit to 12x12 foot spacing (302 trees per acre) -Cut primarily silver fir and western hemlock -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall -If no Douglas fir, or western red cedar present thin the alder to 12x12 foot spacing -Keep all thinning related slash away from streams -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	42	
52	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	42	
62 (note: this unit is only accessible by hiking into it)	<ul style="list-style-type: none"> -Thin unit to 13x13 foot spacing (258 trees per acre) -Prioritize Douglas fir and noble fir as leave trees -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall in the unit -Keep all thinning related slash away from stream -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 	23	
62	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	23	

Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

(Page 5 of 7)

UNIT #	PRESCRIPTION	ACRES	PER ACR
65	<ul style="list-style-type: none"> -Thin unit to 14x14 foot spacing (222 trees per acre) -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall in the unit -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall on the decommissioned road leading from the end of the drivable 812 road into unit 62 (13x13 foot release) -Maintain a slash free path for the purpose of human travel on this decommissioned road 	30	

	<ul style="list-style-type: none"> -Keep all thinning related slash away from stream -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) 		
65	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	30	

Note: all trees \geq 12" (one foot) tall will be considered target trees for restoration thinning

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET*(Page 6 of 7)*

UNIT #	PRESCRIPTION	ACRES	PER ACR
74	<ul style="list-style-type: none">-Thin unit to 13x13 foot spacing (258 trees per acre)-Cut primarily silver fir and western hemlock-Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall in the unit or on or adjacent to the 200.4 or 205.2 road-Keep all thinning related slash away from streams and open areas-Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 8x8 spacing-No trees may be cut within an inner gorge. Trees above the upper break of the inner gorge that are within 10 feet of the upper break will be thinned to 10x10 foot spacing.-For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams	55	
74	<ul style="list-style-type: none">-Lop entire unit leaving thinning slash no greater than 18" from forest floor	55	

SECTION A: PRESCRIPTIONS AND BID INFORMATION SHEET

(Page 7 of 7)

79	<ul style="list-style-type: none"> -Thin unit to 15x15 foot spacing (194 trees per acre) -Cut no Douglas fir >6 inches dbh -Cut red alder if it is competing with a Douglas fir, noble fir or western red cedar tree that is > than one foot tall (15x15 foot spacing) -Keep all thinning related slash away from streams and open areas -Thin the first 20' (either side = 40' total) adjacent to the stream buffers to a 10x10 spacing (thin buffer strips adjacent to streams to a tighter spacing than that prescribed for the unit) -No trees may be cut within an inner gorge. Trees above the upper break of the inner gorge that are within 10 feet of the upper break will be thinned to 10x10 foot spacing -For all units, no trees are to be cut if any part of their canopy drip line is over or within the bank full width of any annual or perennial stream, or wetland, or pond, or the upper break of an inner gorge. Road ditches are not considered streams 	46	
79	-Lop entire unit leaving thinning slash no greater than 18" from forest floor	46	
	TOTALS	632	

Note: all trees >or = to 12" (one foot) tall will be considered target trees for restoration thinning

Appendix D. 2006 Data Collection Protocol

DATA

(as indicated as column headings on plot card)

- BAF/FIX: All plots will be 1/100th acre fixed plot size unless otherwise indicated. Circle FIX and write 100th in column
- Plot #: indicate plot number. For example, plot 1, plot 2 etc. Please indicate location and numbering scheme on the unit maps.
- Tree #: indicate tree number. For example, tree 1, tree 2 etc.
- Sp: indicate tree species. Use genus species acronyms. For example: Douglas fir psme.
- DBH: record to nearest inch. Use size class breaks: 0-0.4 = 0; 0.5-1.4 = 1; 1.5-2.4 = 2 etc.
- # Trees: record number of trees of that diameter and species. For example you may measure five western hemlock trees that are one inch dbh on a plot; in this example you would put 5 in the # trees column for that entry.
- Height: You do not need to record all heights in a plot. Across all plots located within a unit get a representative tree height from all species and diameter classes.
- %live crown: estimate this in 10% increments; for example: 30%, 20%, 10%
- Age: Core one or two trees per unit (not plot) in the dominant/co-dominant size class at dbh. Measure and record tree height for these cored trees.
- St #: Record number of stumps found on a 200 foot x 6 foot transect. Locate the transect start point at plot center with the transect located directionally toward the next plot. Only count stumps where the mid-point falls within the transect.

- Dia: estimate the stump diameter
- Comments: indicate % cover per plot of specific under-story species (list is attached). % cover scale should reflect the following <1%, 1-5%, 6-25%, 26-50%, 51-75%, 76-95% and >96%. Note: this information will be used for plant association relationships and use of FVS for growth modeling. FVS determines site productivity based on plant association.
- Comments: indicate species of stumps if obvious
- Comments: any thing else relevant to the unit to be considered in crafting prescriptions, or worthy of noting.

OUTPUT PRODUCTS EXPECTED:

- A Unit map of each unit sampled. This map will include the following:
 1. any boundary adjustments illustrated
 2. locations of plots and numbers corresponding to each
 3. stand typing as appropriate. For example, if it is determined by the plot taker that sub-units exist within a larger unit (based on site quality, vegetation response, animal impacts, etc.) the boundary of these sub-units should be indicated on the unit maps with the corresponding unit numbers: 1a, 1b etc.
 4. locations of GPS points
- Plot cards from each unit sampled.
- Data-base of manually entered data from plot cards (ms excel) note: a simple legal description (township range section) for each unit will be included in the database. For those units that are located in multiple sections include only the dominant section in the legal description. The legal description information is provided on the unit maps.
- Completed plot cards and corresponding maps will be filed in an Accordion file system with numbered dividers. File the plot cards and maps by the unit rank number.

List of indicator species
For comment column on the plot card
Note: Plants in bold are “priority” plants

Common name	Code	Genus	Species	Growth form
Pacific silver fir	ABAM	Abies	amabilis	tree
Subalpine fir	ABLA	Abies	lasiocarpa	tree
Vine maple	ACCI	Acer	circinatum	shrub
Vanilla leaf	ACTR	Achlys	triphylla	herb
arnica	ARLA	Arnica	latifolia	herb
Lady fern	ATFI	Athyrium	filix-femina	fern
Deer fern	BLSP	Blechnum	spicant	fern
Marsh marigold	CABI	Caltha	biflora	herb

Menzies' pipsissewa	CHME	Chimaphila	menziesii	herb
Princes pine	CHUM	Chimaphila	umbellata	herb
Copperbrush	CLPY	Cladothamnus	pyrolaeiflorus	shrub
Queen's cup	CLUN	Clintonia	uniflora	herb
Bunchberry	COCA	Cornus	canadensis	herb
Western coralroot	COMA	Corallorhiza	maculata	herb
Salal	GASH	Gaultheria	shallon	shrub
Sweet-scented bedstraw	GATR	Galium	triflorum	herb
oak fern	GYDR	Gymocarpium	dryopteris	fern
Skunk cabbage	LYAM	Lysichiton	americanum	herb
False lily of the valley	MADI	Maianthemum	dilatatum	herb
Oregon grape	MANE	Mahonia	nervosa	shrub
Devils club	OPHO	Oplopanax	horridus	shrub
Red heather	PHEM	Phyllodoce	empteriformis	shrub
Sword fern	POMU	Polystichum	munitum	fern
Douglas-fir	PSME	Pseudotsuga	menziesii	tree
Sidebells pyrola	PYSE	Pyrola	secunda	herb
White-flowered rhododendron	RHAL	Rhododendron	albiflorum	shrub
Dwarf bramble	RULA	Rubus	lasiococcus	shrub
Five leaved bramble	RUPE	Rubus	pedatus	shrub
Rosy twisted stalk	STRO	Streptopus	roseus	herb
Western red cedar	THPL	Thuja	plicata	tree
Foamflower	TITR	Tiarella	trifoliata	herb
Western hemlock	TSHE	Tsuga	heterophylla	tree
Mountain hemlock	TSME	Tsuga	mertensiana	tree
Alaska blueberry	VAAL	Vaccinium	alaskaense	shrub
Blue-leaf huckleberry	VADE	Vaccinium	deliciosum	shrub
Black huckleberry	VAME	Vaccinium	membranaceum	shrub
Oval-leaved blueberry	VAOV	Vaccinium	ovalifolium	shrub
Red huckleberry	VAPA	Vaccinium	parvifolium	shrub
Sitka valerian	VASI	Valeriana	sitchensis	herb
Bear grass	XETE	Xerophyllum	tenax	herb